THE

ELECTRICAL REVIEW.

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THE

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COLONIAL EXPANSION AND TELEGRAPHIC COMMUNICATIONS.

IT was shown in our last issue that Sir Charles Dilke's arrival at the rock with a "red" cable did not bring to us all that could be desired. Our lines to India, &c., have been under Toulon—shall we say much too long, to make us eager to put others down under the strongholds of Brest and Cherbourg, and it must be decided that the only hope of reaching Australia and the Cape with some degree of safety is by the Pacific, in which ocean there are also important islands waiting to be connected with the outside world. It is impracticable and unwise to put all our lines down in one direction.

We, however, strongly recommend Sir Charles to use his great ability in bringing to a successful issue the New Alaskan boundary treaty, which will bring Canada back to the lines of the Anglo-Russian treaty of 1825. It is very important that the proper rendering of that treaty should be secured, as it would permit of a little more breathing space on the Pacific slope, and also we think the elimination of the only weakness which can be brought forward by the opponents of the Pacific cable scheme, viz., the landlines through Canada. At the present moment, British enterprise in the direction of telegraphic expansion is represented by innumerable discussions, while France is manufacturing and laying cables, and building and chartering cable ships, out of funds derived from subsidies granted by the French Government, or from profit from the working of some of their cables. Thus, while our more energetic neighbours (even the Germans have laid a cable and had a "break") are absorbing parts of the Pacific, and probably the most of the Caribbean, we are still engaged in discussion. One of the unfortunate reasons for British stagnation is, we think, the deterrent influence brought to bear by enterprises which are in receipt of the bulk of all subsidies and guarantees. Colonies are practically forced to support by subsidy services which do not meet their wants, and they actually endow enterprises which are defeating means put forward by them for the amelioration of their telegraphic lines. When treating of the increase in population and commerce (it is an impossible thing to keep down an Anglo-Saxon), it would have been well had it been stated whether the increase was as large as it should have been. The question, so far as we understand it, now occupying the attention of the Commissioners in the West Indies, is not the ruin of those colonies, although there is much quiet suffering and poverty in some of them, but the saving of an industry which has, until recently, been profitable. Here below is the value in sterling of the trade done with the Caribbean in 1895:—

1. Great Britain	about	8¼	millions.
2. Canada	„	1¾	„
3. United States	over	20	„

These results are due to the close proximity of the States, and to there being no means of annihilating

distance, such as quick steamers and direct cable communication, and also to the present—commercial and political—method of educating British colonies from New York. The colonists object to this condition of affairs, and we have shown the means whereby they are made powerless. The reason, therefore, that they play with us a less part than in 1837 is not due to causes emanating from them, but to British indifference, and no better object lesson could exist than the exhibition of foreign made goods now controlling West Indian markets, recently held at the London Chamber of Commerce. At the Society of Arts, on February 16th, Mr. J. G. Colmer, who has for so long occupied the Deputy Commissionership for Canada in London, read a paper on "The Progress of Canada during the Sixty Years of Her Majesty's Reign." From this gentleman we had the expressed desire for the early completion of the two missing links, viz., that from Bermuda to Jamaica, and the Pacific cable from Vancouver to Australia.

ALLOYS.

Of appalling length is the list of meetings of societies which appears week after week in the scientific and technical journals at this period of the year, and from a mere glance at the titles of the various papers down for reading and subsequent discussion, it is obvious that anyone who aims at being well informed and thoroughly up-to-date as regards the most recent advancements in theoretical and practical engineering and science, has by no means a light task before him. In fact, so great is the pressure, that to keep at all *au courant* necessitates one continuous grind. In extenuation, it may, of course, be said that the range of subjects is extremely wide, and that only a few, comparatively, are of interest to particular individuals; but, even with this limitation, it must be admitted that there is a tremendous amount to be read and assimilated. Take, for example, the case of the central station engineer, and it will be found that the number of papers scientific, electrical, and mechanical, which he cannot afford to ignore, is manifold and innumerable.

The subject of alloys is one which may not in the first instance appeal directly to many engineers, but the bare fact that two alloys—steel and brass—are at the present time of such engineering and industrial importance, should more than suffice to dispel any apathy in the matter. Any advancement of our knowledge of the physical and chemical laws which govern the composition and regulate the properties of these substances, must at the same time benefit engineering generally. It is to the Institution of Mechanical Engineers especially, that the greatest credit is due for bringing the study of this subject prominently to the front during the last few years. The fourth report of the Alloys Research Committee recently presented by Prof. Roberts-Austen gives an excellent *resumé* of the latest investigations and the present state of our knowledge. Prof. Roberts-Austen's work has mainly been in the direction of tracing a relation between the mechanical properties of the metals depending on the "periodic law" of Newlands and Mendelejeff. This now well-known law states that "the properties of the elements are a periodic function of their atomic weights." The original problem for consideration by this Committee was to investigate the effects of impurities on the mechanical and physical properties of such commercially important metals as iron, copper, and lead, &c.

The term alloy is used to denote the resulting compound which is formed when two or more metals are melted together and enter into combination with each other. Now, it is a fundamental fact in chemistry, that when compounds are formed the constituents combine in certain fixed proportions. In the case of alloys, however, as in mechanical mixtures and solutions, the constituents combine in different proportions, and although there is proof that true compounds of the metals do exist, they are in many cases mixed with an excess of one or other of the constituents. It is this property of alloys which lead to Matthiessen's conception of them as "solidified solutions."

We know from experiments that many of the physical properties of a metal are changed by adding to it a small portion of another metal, and that the resulting alloy is often adapted for purposes for which either metal would, by itself, be unfit. Consider iron. We know that the addition of a certain percentage of carbon increases its tensile strength, and also, to a degree which depends on the rate and extent of its heating and subsequent cooling, produces hardness. As to copper, we know the deleterious effects of impurities on its electrical conductivity, "and that if the copper of which a cable is made contained only $\frac{1}{1000}$th part of bismuth, this impurity would be fatal to the commercial success of the cable."

But what we want to know much more about is the cause of the formation of alloys, and the laws relating to them. On these points our knowledge is as yet very imperfect, and we must await further developments before we can explain what appear at present mysterious results. The investigation is one which includes many branches of physics and chemistry, and is undoubtedly dependent on some of the most subtle questions connected with those sciences, of which we are only now perhaps on the threshold of a satisfactory solution.

Before we are able to predict what will be the fusing point, conductivity, elasticity, tenacity, and other physical properties of alloys, and understand the laws which govern them, our insight into the hidden secrets of the smallest particles of matter must be considerably increased. Further developments in the kinetic theory of gases, involving a study of the statics and dynamics of the atoms themselves, and an explanation as to what chemical affinity is, seem the most likely sources from which to expect future enlightenment. The whole subject of alloys is still an interesting study, and to give an idea of the nature of the work that is required to understand it, we will quote from Prince Kropotkin's article, "Recent Science," in the February number of the *Nineteenth Century*:

"What we want to know about the solids is not the arrangement of their rougher particles (that much is learned easily enough by the aid of the microscope); we want to penetrate far beyond the utmost limits of microscopical vision; to know how the molecules, which are so minute as to defy the powers of our best microscopes, are arranged; how they are locked together; in how far they are free in their movements, and what sort of movements they perform; what is, in a word, the inner molecular life of a seemingly inert block of metal."

Communication between Lightships and the Shore.

The general tenor of Mr. Willoughby Smith's letter to the Electrical Review last week, would appear to convey the mistaken impression that the principal feature of one method of establishing electrical communication between shore and lightship, alluded to in our article of December 25th, formed part of another method referred to at the same time, whereas the two are entirely distinct. In our article of December 25th, paragraph 7, the report of the U.S. Lighthouse Board is quoted, and it is pointed out that full details of experiments carried out with (1) the method of making use of the ships anchor chain; and (2) the so-called diffusion method, will be found therein. The first practical experiment at Wood's Hole, Mass., where the lightship's chain formed part of the circuit, was entirely different from the practical trial at the Scotland lightship in obtaining telephone communication by means of electrifying the region of water in which the vessel would swing at her mooring, and no mention whatever is made in the second part of our article of the lightship chain being used in connection with this particular trial between Sandy Hook and the Scotland lightship. Mr. Willoughby Smith in that portion of his communication referring to Prof. Blake's first practical experiment at Wood's Hole, Mass., where the end of the cable was connected to the mooring chain, and when good results were obtained, &c., goes on to say that "Encouraged by this result, Prof. Blake attempted to obtain the same effect at the Scotland lightship off Sandy Hook, but failed because of . . . . . the entirely different conditions . . . . and instead of one mile from shore . . . . the Scotland lightship was four miles distant." Mr. Willoughby Smith further remarks in the next paragraph that "under these circumstances he, Prof. Blake, coated the mooring chain with an insulating bituminous paint, and thus partly converted the non-continuous into a continuous cable system." We have Prof. Blake's report to the U.S. Lighthouse Board before us, and after describing the experiments at Wood's Hole, Mass., and the incidental observation, which we referred to in our article (12th paragraph) of a submarine cable having become foul of the Scotland lightship's anchor chain (its copper conductor making metallic contact with same, and causing a receiving telephone in connection with the hawse pipe of the ship to be heard, thus indicating direct metallic connection through to the shore), we note that Prof. Blake, in commencing his description of his second method, says: "The anchor chain was not made part of the telephonic circuit in this method, but the entire region of water in which the ship could swing was electrified in such a way by the telephone current as to present differences of potential at different points in its area sufficient for telephonic purposes." We cannot reproach ourselves with having, unfortunately, conveyed an erroneous impression, because we simply stated throughout our article what is contained in the official report of the U.S. Lighthouse Board, and we have no knowledge of any other practical trial of the latter method in question having worked satisfactorily over a period of six months in any other part of the world. Into the merits of priority in the initiation and application of the non-continuous conductive system we do not enter.

Mechanical Drawing.

In a recent lecture to the Marine Engineers' Institute at Stratford, Mr. Brett emphasised the fact that though neatness was desirable, the true object of drawing was to explain. We judge that his remarks on this point could be summed up by saying that he would prefer a roughly sketched circle marked 4 inches diameter by ½ inch thick to delineate a piece of plate of those dimensions, to a carefully drawn circle and rectangle without any figures, and needing a scale to find the dimensions. A drawing should, in short, embody on its face, lines, figures, and writing, to just such extent as will suffice to enable the article delineated to be made. It would often render a drawing too complex to indicate by actual drawing what may be more plainly rendered in words and figures, and, to our mind, that pedant style of drawing which shows every bolt and nut other than by a mere centre line, is a sinful waste of time, unless the picture of the bolt serve, as may be sometime the case, a special and useful purpose. To engineers the capacity to draw intelligently is a gift that, if wanting, must often prove a serious loss, and the fact that, as a rule, the old draughtsman is rare, may be taken, we think, to show that those who possess the power have advanced to something better. As a rule, we think the ability to draw must be coincident with the power of first mentally picturing the object. When such object cannot be pictured, the first sketches are little more than a means to prepare and assist the mind to form such picture. The important items in drawing are, says Mr. Brett, to begin with all the centre lines that can be put in and to work therefrom, to carry the principal centre lines right across all views and projections, and to show the extreme positions of all moving parts and the paths of motion as well as being carefully figured and noted. Mr. Brett advises the study of geometry to be concurrent with the study of drawing. The more complex problems, such as those connected with certain cam motions derived from inclined moving pieces have been found in the present writers experience to be much facilitated by familiarity with geometrical problems. As a rule we think also that the really simple and extremely useful art of isometrical drawing is far too little employed. If a scheme of steam piping is to be arranged, the one isometrical view is infinitely superior to the double or treble views otherwise needful, and the safety and accuracy of taking out the lengths and the number of bends, tees, and valves, is very much enhanced. The Chairman, Mr. Adamson, had some remarks to make on the question of piping, but omitted to show how the art of isometrical drawing would assist towards the better placing in the bilges of roses and valves. The great fault of draughtsmen is that too many of them have had too little working experience, and do not design their work from the standpoint of the man who has to do the repairs.

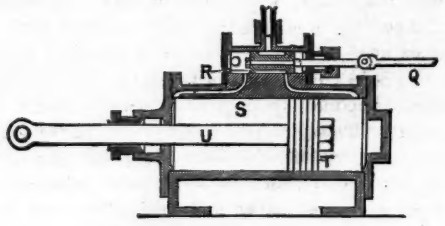
Another Forty Knotter.—"Of course," says the *Shipping World*, "it is an inventor, and equally of course an American inventor, who informs us that he has devised the ubiquitous 'electrical plant' for propelling ships at the rate of 40 knots an hour. This time we are to have a mere matter of 16 propellers, eight on each side, as well as two of 'ingenious construction' at the end—which 'end' is not stated. These are to be driven by motors 'built direct on the propeller shafts,' and one or all can be independently operated from a switchboard, the reason for doing which is somewhat involved. So far so——? But when the inventor tells us that the engines for generating the electricity are to be carried on board, we are at once brought from the world of fancy to the hard and fast matter-of-fact losses that occur between engines and dynamos, augmented by further losses between dynamos and—in this case 18—motors, little details the neglect of which has sorely perplexed the Russian gentleman whose electrically-to-be-propelled yacht, recently tried on the Clyde, proved such a fiasco. The ideal 40 knotter will have to be devised by an inventor who will calmly sit down—that is, if the breed ever does sit, calmly or otherwise—and think out to a finite solution some such problem as this:—Coals are heavy, and take up space, therefore the motive power must come from outside the vessel; therefore we must 'tap' Niagara, throw an aërial cable across the Atlantic, and collect the current from a 'trolley,' as is done with tramcars, while we go along. This seems feasible, but we should much prefer to leave the details to the inventor."

D

THE PREVENTION OF RACING IN MARINE ENGINES.

It is well known that the racing of marine engines is caused by the propeller being raised more or less out of the water by the pitching of the vessel, or by the water leaving the propeller as the stern is passing across the hollow of a wave. In either case the immersion of the stern part of the vessel in the water is less at that time than when the vessel is floating in comparatively still water. This difference of immersion has been utilised by Mr. J. S. Yabsley, of Yokohama, to effect, by electrical means, the closing and opening of a throttle valve, which regulates the supply of steam to the engines.

Fig 1.



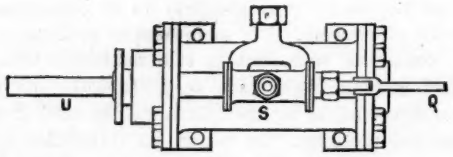
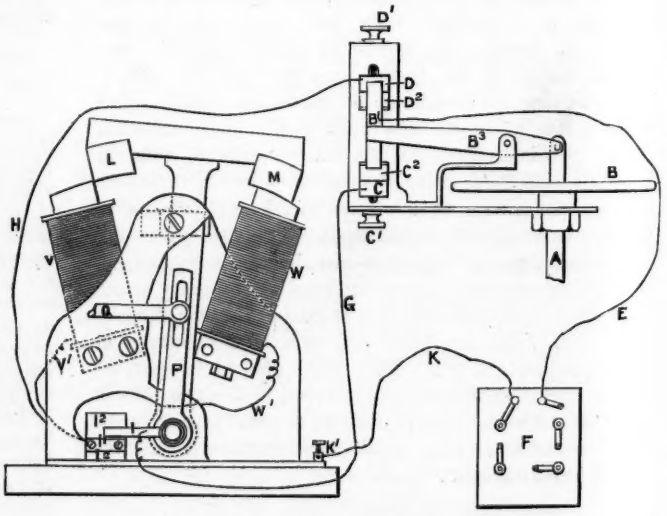


Fig. 2.

A pipe is fitted at the stern of the vessel, as near the bottom as possible, and opening to the sea but preferably closable by a tap or valve. To the other end of this pipe is fitted an elastic corrugated metal chamber similar in construction to that used in certain kinds of pressure gauges and aneroid barometers. When the tap or valve, in the pipe leading to the water outside the vessel, is open, the bent tube will be subjected to internal pressure proportionate to the head of water there may be at any time between it and the surface of the sea, and consequently proportionate to the immersion of the part of the vessel where the connection between the tube and the sea happens to be placed. As the corrugated chamber expands or collapses according to the pressure there may be in it, it makes or breaks contact with a source of electricity which supplies current to an electric motor, or to the coil of an electro-magnet, which acts upon the slide valve of a small steam cylinder, the piston of which is connected with the throttle valve of the main engines. By this arrangement whenever the stern part of the vessel comes to be immersed in the water to such a depth that the engines would not race, the pressure of the column of water, acting on the corrugated chamber, causes it to close the circuit between the source of electricity and the motor or electro-magnet; the latter then moves the valve of the steam cylinder so as to admit steam to that side of the piston, which causes the latter to open the throttle valve of the main engine. That done, the commutator of the motor or electro-magnet will open the circuit, so as to avoid waste of electric energy until it is required to move the valve of the cylinder again. When, however, by the pitching of the vessel, or from other cause, the immersion of the stern part is reduced, the pressure of the column of water acting on the corrugated chamber will be reduced in proportion, this closes another electric circuit which causes the motor or electro-magnet to move the valve of the steam cylinder in the opposite direction, admitting steam to the other side of the piston, so that the throttle valve is closed and the electric circuit broken, as before, by the commutator.

The actual arrangement of the apparatus is shown by figs. 1 to 7. The corrugated chamber, B^*, is caused to expand under an increase of pressure due to an increase in the head of water outside the vessel, and to contract under a decrease of pressure due to a decrease in the head of such water; and this expansion and contraction acts upon a lever, B^3, which carries at its outer end a brush or contact maker, B^1, which makes contact with the metallic plate, D, when in its upper position, as shown in fig. 6, or with the metallic plate, C, when in its lower position. When the upper end of the brush, B^1, is in contact with the metallic plate, D, its lower end is in contact with the non-conducting material, C^2, and when the lower end of the brush, B^1, is in contact with the metallic plate, C, its upper end is in contact with the non-conducting material, D^2. In the figures, the chamber, B^*, is supposed to be collapsed in consequence of the part of the vessel where the propeller is placed being deprived of water to a certain extent, this has raised the contact-making brush, B^1, into contact with plate, D, and as the brush, J, is, in the position of the electro-magnetic motor or apparatus shown in figs. 3 and 4, in contact with the metallic plate of its commutator, J^1, current passes from the battery, F, by conductor, K, to the terminal, K^1, thence by conductor, K^2, electro-magnet, V, and conductor, V^1, to metallic plate of commutator, J^1, thence by brush, J, conductor, H, plate, D, brush, B^1, and conductor, E, back to battery, F. This passage of the current causes the electro-magnet, V, to draw the armature, L, and with it the armature, M, from right to left, pushing the rod, Q, in the same direction, and operating the valve, R, of steam cylinder, S, admitting steam to the piston, T, and closing the throttle valve. This movement of the armatures, L, M, brings brush, J, off the metallic plate of commutator, J^1, on to the non-conducting part of that commutator, thus breaking the current, and at the same time bringing brush, I, into contact with metallic plate, I^1, in readiness for the next movement, electric connection of the plate, I^1, with the battery, F, being broken by the brush, B^1, resting on the non-conducting part, C^2.

When the proper depth of water is restored at the part of the vessel where the propeller is placed, the chamber B^* is expanded by the pressure of such water, the brush, B^1, is lowered so as to bring its lower end in contact with plate, C,



Figs. 4, 5, and 6.

and current then passes from battery, F, by conductor, K, to terminal, K^1, thence by conductor, K^3, electro-magnet, W, conductor, W^1, metallic plate, I^1, brush, I, conductor, G, plate, C, brush, B^1, and conductor, E, back to the battery, F. This passage of the current causes the electro-magnet, W, to draw the armature M, and with it the armature, L, from left to right, drawing the rod, Q, in the same direction, and operating the valve, R, of the steam cylinder, S, so as to admit steam to the

opposite side of the piston, T, in order to open the throttle valve. This movement of the armatures, M and L, brings the brush, I, off metallic plate, I^1, on to the non-conducting part of that commutator, thus breaking the current, and at same time brings the brush, J, into contact with the plate, J^1, in readiness for the next movement, electric connection of the plate, J^1, with the battery, F, being broken by the brush, B^1, resting on the non-conducting part, D^2.

As the tube, B, or chamber, B^*, as the case may be, is necessarily in communication with the sea it is obviously necessary to insulate from it the part, B^1, by which the electric circuit is completed through the contact makers, C and D, and that the conductor, E, shall be connected with that part but otherwise insulated.

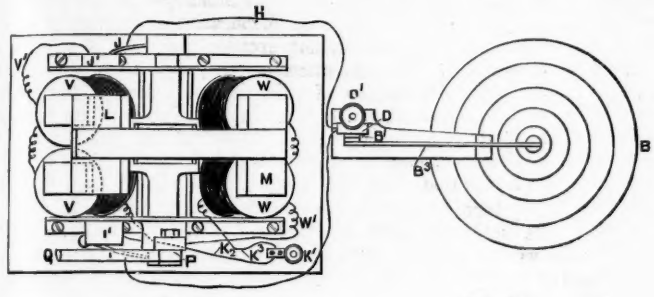


Fig. 3.

Fig. 7.

By the arrangements above described the throttle valve may be closed before any racing occurs, even in a heavy sea, which cannot be effected, so far as the inventor is aware, by any marine governor heretofore in use, because in all such governors the racing actually commences before the mechanism for closing the valve can be brought into action, whereas by this invention the reduction of the immersion brings about the closing of the throttle valve before there is time for racing to commence. Furthermore, in these arrangements the throttle valve may always remain connected to the regulating parts, because the latter will not act unless and until the immersion of the stern of the vessel is reduced to the prearranged extent, thereby preventing the unnecessary slowing down of the ship which takes place when the throttle valve is closed by hand in anticipation of racing, which may or may not occur.

That the apparatus is thoroughly efficient is indicated by the following extracts from the "log" of the ss. *Kaisha*, to which vessel the gear was fitted :—

Left Yokohama 12 noon, strong fair wind and sea. Yabsley's patent electric governor was put in gear at 3.30 p.m., engines racing, and weather looking bad; 5 o'clock p.m. strong head wind with heavy sea, governor acting well; 7 o'clock p.m. blowing a gale with very heavy sea, ship labouring very much, governor acting like a charm, keeping the engines under full control, anticipating the rising and falling of the propeller, shutting the throttle valve just before the racing would take place and opening again in time to prevent slowing down of engines.

Friday, March 9th, 1894. Still blowing a gale of wind with very heavy sea, ship labouring much and shipping water, pitching very heavy at times. Yabsley's patent electric governor in gear, all the time keeping the revolutions very regular without slowing down; 6 p.m., weather moderating; 8 o'clock p.m., disconnected governor.

L. Harlan, *Chief Engineer*.

The engines of this ship are N.H.P. 250.

A NEW THREE-WIRE DYNAMO.

By T. R. D. KENNY.

The three-wire dynamo, which was described some time ago in the *Electrical World* by Mr. A. Rothbert, and by M. Alimet in *L'Electricien*—extracts from which are to be found in the Electrical Review for December 25th, 1896, and January 22nd, 1897, respectively—is of considerable interest, as it combines in one dynamo some of the principal advantages of the two units hitherto used for balancing a three-wire system of distribution.

If the machine behaves as the writers make out, it should be very suitable for supplying the light load in a small three-wire station as well as balancing, for if the battery charging were done by the help of a "booster," the whole station could be run by one engine. Had this dynamo appeared, however, some years before the expiration of the Hopkinson three-wire patent, it is possible that it would have met with a large demand from central station engineers employing that system; for, since Hopkinson claimed the employment of three or more conductors, in combination with *two or more* dynamos (evidently in series), the use of a single machine with a neutral brush, would very probably have avoided the royalties demanded by the owners of that important patent.

For such a machine to be entirely equivalent to two smaller dynamos, the following conditions should be fulfilled.

I. Each side of the armature should be capable of independent adjustment from full load to no load, as well as

II. To admit of the more heavily loaded side being of considerably higher pressure than the side with less load. This latter condition is essential for proper balancing, as it is not sufficient that each branch should have the same voltage, but be capable of giving different loads —as is mentioned in one of the extracts referred to above. If there is want of balance, the more heavily loaded generator has to supply—in addition to the extra voltage lost in its own armature—the extra drop in the external circuit caused by the unequal loading. It must, therefore, work at higher pressure.

III. The equivalent of two units should admit of one side being switched off and run on open circuit, then the E.M.F. of this side to be reversed, and finally coupled in parallel with the remaining side. If this could be done satisfactorily the balancing power of the machine would be doubled, and a smaller machine would be capable of dealing with a greater difference of load.

IV. No coil on the armature should be overloaded, when either side of the machine alone is fully loaded, *i.e.*, when dealing with a current in the neutral wire, equal to the maximum rated output of the dynamo on a balanced circuit.

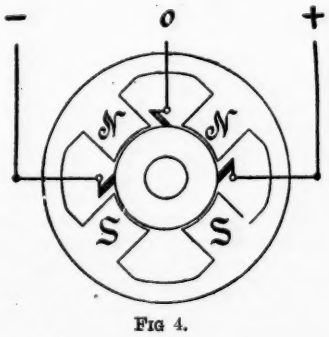


Fig 4.

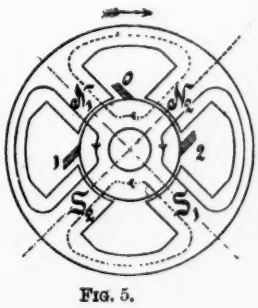


Fig. 5.

V. There should be no sparking at any of the brushes.

It is interesting to see how far this new dynamo satisfies the above requirements.

By connecting the windings of opposite poles in series, thus forming two independent magnetic circuits, conditions I. and II. are, I think, realised in M. Müller's machine, although there is no mention in the papers of one side being run at little or no load, the other doing full duty. The objects of the experiments cited, seems rather to have been to show that the pressure of the two sides can be kept the same by adjusting the independent field windings, as the load increases equally on both sides; and to find the difference in the exciting currents producing this result. The constancy of pressure seems natural to expect under the conditions, as is also the difference between the exciting currents, which disparity of course shows the effect of armature reaction; but, judging from diagrams 4 and 5, given in original papers (see Electrical Review, page 96), and reproduced, one

would expect the contrary to that stated (and given in table of results), by M. Alimet, where he points out "that the positive excitation has to be increased with the output"; as from the direction of the armature rotation, and the polarity of the field magnets, it is clear that the flux through the positive side of the armature is augmented instead of diminished by the armature reaction.

The armature described is of the ring type, but there is no reason why a drum should not be used in the same manner. Suppose then we have a ring or drum armature capable of delivering 200 amperes to the outer circuit, to be used in a balancing machine on M. Müllers plan. For it to fulfil requirement III., it means that the excitation of N_2 S_2, say, is to be reduced until the current in the positive brush (2) falls to zero, then the switch in this circuit is opened and the exciting current of N_2 S_2 switched off. With this arrangement we would have two wound poles, and two unwound (or unexcited)—a field similar to that of the machine described by Prof. Elihu Thomson about a year and a half ago (and published in the REVIEW about that time) in which the armature reaction played such an important part in connection with the unwound poles. Suppose now, however, that the armature reaction in connection with these unexcited poles does not interfere very seriously with the load going out on the negative side through brush (0), and we excite N_2 S_2 in the reverse direction, an arrangement of field is produced which makes brush (0) positive to brush (2), as well as to the negative brush (1). (It will be noticed that this field is similar to that in fig. 5, only twisted through 90° counter clockwise). If now brushes (1) and (2) are metallically

FIG. A.

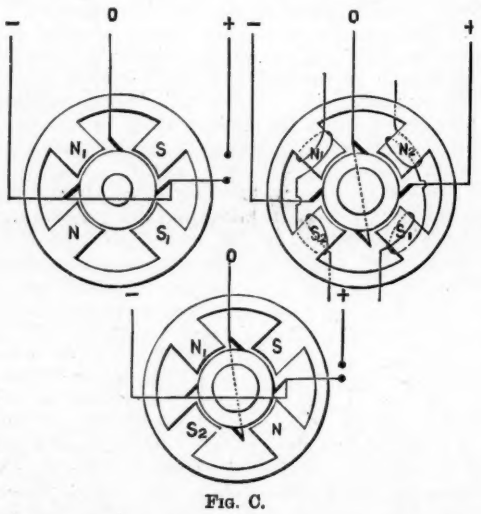


FIG. B.

FIG. C.

connected, we should be in a position to get double the current into the centre wire, both sides of the armature being then in parallel. See fig. A. If this operation could be gone through satisfactorily without altering the output from the loaded side, it should certainly enhance the value of the machine for central station work.

Since the coils of an ordinary ring or drum armature, of a bipolar 200 ampere machine, are fully loaded with 100 amperes, M. Müller's machine cannot, I think, fulfil condition IV.; for to do so it is necessary that the armature should supply 200 amperes to the centre wire, without overloading any coil, which is clearly impossible as *all* the centre wire current passes through *one-quarter* of the armature conductors in his arrangement. To remedy this, one would naturally suggest the use of *two* centre wire brushes, placed diametrically opposite on the commutator, as this would distribute the centre wire current more evenly; but a closer inspection will show, that if two brushes are used, the balancing property of the armature would be entirely removed, for it would then be impossible to produce a higher pressure on one side of the neutral-wire brushes than the other. These remarks apply to both ring and drum armatures alike, if used with M. Müller's arrangement of field windings.

If, however, we use a *ring* armature, and connect the field bobbins, N_1 and S_2, in series, and independent of N_2 and S_1 which are also placed in series, it seems possible to use *two* neutral-wire brushes and at the same time to regulate the pressure and load on either side independently. (This regulation could not be effected if a *drum* armature were used instead of a ring). It should then be possible to have 200 amperes flowing in the centre wire, without any coil experiencing more than 100 amperes. See fig. B.

It remains now to be seen if this last arrangement of field winding in connection with a ring armature and two centre wire brushes can fulfil condition III.; that is, admit of the positive and negative sides being changed from series to parallel, when one side is under load. To do this the excitation of N_2 S_1, say (the positive side), must be gradually lowered, and the switch connected with brush (2) thrown, at the same time keeping the current in negative side constant —to do which, it looks as if the exciting current of N_1 S_2 would have to be continually increased, as that of N_2 S_1 was diminished. The excitation of N_2 S_1 must then be reversed and gradually increased in the reversed direction, whilst the current round N_1 and S_2 is gradually reduced to its normal amount. (An arrangement of rheostats and switches could be designed, so that these several operations might be performed by turning one handle). We should then have a four-pole field, with consecutive poles, as shown in fig. C, which would allow of brushes (1) and (2) being coupled together, and a current of 400 amperes passed into the centre wire, and this, without overloading any portion of the armature.

If the above operations can be performed in practice, then conditions III. and IV. are successfully fulfilled.

We learn from the papers referred to, that the brushes of the Frankfort machine behaved well for load differences in the ratio of 1 : 2. So far, at least, condition V. has been realised, but for balancing purposes we should like to have sparkless commutation with greater inequalities of load, especially if the dynamo is small. In fact, this last requirement is the most imposing, it being the criterion which must be applied to the proper fulfiment of the other conditions, as an experimental dynamo can be made to do almost anything, except stop sparking.

From theoretical considerations it seems difficult to see why there is not at least some sparking at brush (2) say, when carrying 100 amperes, if brush (1) has been adjusted to commute 200 amperes sparklessly (that is with loads in the ratio of 1 : 2) provided brushes 1 and 2 are fixed diametrically on a common rocker. Of course, not having seen the original papers, I am unable to say if these details are mentioned; but I should think condition, V., might be more easily realised if the brushes were fixed so as to be independently adjustable. It should be mentioned that these remarks apply equally to the arrangement suggested above by me (and shown in fig. B) where a fourth brush is used. Also that the fourth brush and independent rockers, seem to increase the liability of local and useless currents flowing in the armature, under certain conditions; but experiment should best decide this point.

With the direction of flux and rotation depicted in fig. 5, where brush (1) is negative, it seems to me that with a large load on the *negative* side, there should be some sparking at brush (0); for the pole-fringes on either side of this brush, are of the wrong sign to overcome the self-induction of the short-circuited coil. Of course, this brush would not need such a strong commuting field as the outside brushes (1) and (2), yet in the absence of any reversing influence one should expect sparking here, accompanied by a tendency to raise the pressure of the positive side. If, however, the load is on the *positive* side, there should be no sparking at brush (0).

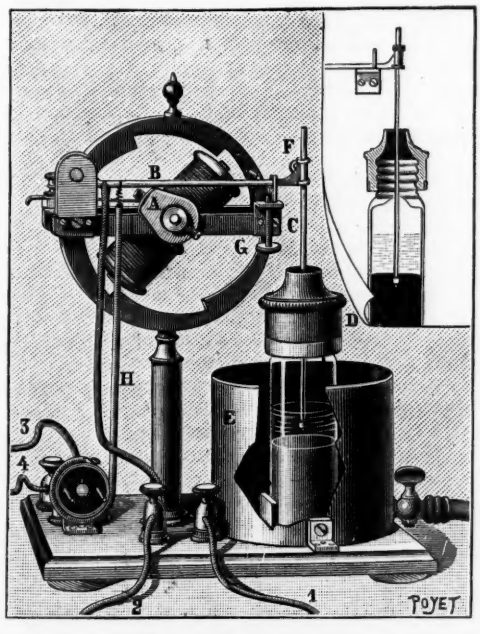
This method of commuting a current by creating a "neutral point" where the brush is to be placed, is of course not new. Sayers provided several such neutral points around the armature of his electro-plating dynamo years ago, for the purpose of collecting currents at different voltages. But the ingenious combination of three brushes with two independently controlled magnetic circuits, employed by M. Müller, is, I think, of recent date.

It should be understood that most of the points raised in the above, do not apply to dynamos for separate three-wire plants, where the centre wire current need not exceed a small fraction of the total—but to balancing machines, where there are several larger units working on the outside conductors.

MERCURY INTERRUPTER FOR INDUCTION COILS.

Since Prof. Röntgen's splendid discovery, the induction coil has been required to lend its services for periods of much longer duration than has hitherto been the case, so that it becomes necessary to eliminate certain defects.

In the type of interrupter generally known as the hammer interrupter, the surfaces in contact become heated to such a degree that they are welded together. The bobbin becomes heated, the material insulating the various spirals is melted, we get internal discharges, and, in a few minutes, the apparatus is rendered unfit for use. Moreover, it was to obviate these contingencies that Foucault designed his mercury "trembler," which prevents the risk of accidental soldering. Practice has shown the undeniable advantages of this interrupter, which, besides its reliability of working, gives with the same coil much longer and better sustained sparks. Nevertheless, its rate of speed is less rapid than that of the hammer trembler, and the number of transmissions of current are in the same way greatly reduced. In photographic experiments with the Röntgen rays, it is desirable, when we are dealing with living subjects, to shorten the sittings as much as possible, and it seems probable that there would be an undeniable advantage in making the highest possible number of discharges in the unit of time; this question is, however, the subject of a great deal of controversy, and various eminent scientists, among which we will quote M. Chappius, the learned Professor of Physics at the Ecole Centrale des Arts et Manufactures, maintain that it is desirable not to precipitate the action of the mercury interrupter. However this may be, and placing the question on another footing, we must admit that the limit of the variations of the mercury trembler is not very elastic, owing to the mass of mechanism; moreover, it is impossible to regulate at will the duration of the passage of the current; in fact, as soon as the rod of platinum penetrates into the mercury, it is at once attracted in the opposite direction; we may therefore assume that the periods of contact and of interruption are to all intents equal.



Description of Plate.

Mercury interrupter for induction coils:—A, cam; B, oscillating lever; C, metal contact rod; D, cup containing mercury and alcoholised water; E, reservoir of water; F, screw regulating the contact rod; G, screw regulating the course of the contact rod; H, opposing spring; 1 and 2, wires from the battery working the motor; 3 and 4, wires going to the hammer of the coil and to its fixed contact.

In the course of our researches on photography with the aid of the Röntgen rays, we found that it would be advantageous (1) to increase the number of passages of current in the unit of time; (2) in each passage to diminish the period of interruption corresponding to the extra current.

In order to realise these conditions practically, we have had a special interrupter made by Messrs. Bazin & Leroy, the well-known instrument makers. We will briefly describe it.

An electro-motor (see fig.), worked by an independent battery,* gives a rapid rotatory movement to a central axle, on which a metal cam, A, of a particular form. This cam raises alternately a lever arm, B, to which is suspended the metal rod, C, which plunges into the cup of mercury, D, and produces the contacts and interruptions. By virtue of the form of this cam, the duration of the contact is three-quarters of a period, that of the interruption being only one-quarter of a period. This proportion, which gives the maximum of efficiency, was adopted by us after many careful experiments. The cup which contains mercury and alcoholised water, is immersed in a little reservoir, E, filled with water, the object of which is to prevent heating during experiments of long duration. The contact rod is regulated at the extremity of the lever arm by means of a push, F. A special screw, G, and an opposing spring, H, the length of which is made to vary, enable the course of the lever to be regulated exactly. This interrupter, which is independent of the coil, is connected with it by means of two flexible wires, which are fixed at one end to the part that supports the hammer, and at the other to the contact belonging to the latter. It is necessary to remove the hammer, or to draw it back sufficiently. This apparatus, which is employed with various coils supplied by the best makers, and especially with those made by M. Ducretel, has enabled us to obtain excellent results from a radiographical point of view. The sparks are much better sustained and increase in a very appreciable proportion. The illumination of the Crookes globes is also much more brilliant, and the duration of the sitting is considerably shortened.

For these various reasons we have thought it worth while to describe this little improvement in the apparatus employed in the application of a discovery where much still remains to be done.†—Albert Londe (*La Nature*).

ELECTRICAL ENGINEERING EDUCATION

The question of education, or ought we not rather to say teaching, in engineering subjects is a constant theme of discussion. Naturally, Prof. Francis B. Crocker contends in the New York *Electrical Engineer* for the scholastic method, but he confuses the giving of instruction with the receiving of it, and calls it education, whereas education may be said to begin almost where instruction leaves off. Our professor calls the trouble which is so often experienced with technical graduates "breaking him in," and fails to recognise that really the so-called breaking in is the beginning of education. The boasted education of Germany is, at best, only a sound and good system of instruction, and is responsible for that pigheaded and priggish pedantry which is so offensively obtrusive a feature of the German, and will ever be so until he has learned to distinguish between instruction and the broader thing we understand in England as education. The professor reviews the rapid rise of electrical engineering, and awards praise to what he calls the genius of some of the earlier men who took up electricity with little preparation, and succeeded better than if, as he puts it, they had received a mere education. Here again he confuses education with instruction, and fails to see that it was due to education that they did better than those who have since received mere instruction. Obviously instruction cannot be too full if it do not lead up to pedantry, and it is hardly fair to carp unduly at the young student because he does not at once grasp the difference between the college teaching and the processes of the schools. Prof. Crocker claims in a course of four years that a student

* We might also employ any mechanical motor, provided that the speed can be made to vary sufficiently to produce the maximum effect.

† In the use of the fluoroscope, great inconvenience is caused by the intermittent nature of the illumination of the bulb, which produces a trembling very fatiguing to the observer. By employing an interrupter like the one described above, and giving it a very high speed, we arrive at a continuous lighting of the bulb.

has a thorough grounding in mathematics, physics, chemistry, &c., that he has a general training and possesses systematic methods of thinking, speaking, writing, and working, and a special and complete knowledge of electrical principles and applications, and all this knowledge could not be picked up in ten years outside of an educational institution. Obviously a well-instructed man is prepared for the later process of acquiring knowledge of things as they are. He is like a man who has bought a set of tools and needs only to learn how to use them, and in this respect he is at an advantage with the man who has only a forge and anvil and has to make his own tools. The latter may be left a long way in the rear and may never catch up, but if he be a man of ability he will often be a better man than his earlier instructed rival.

The professor considers that the electrical engineering profession affords as good a road to success as any other line of work, and generally there are more openings than men to fill them, and in any case even if the electrical profession became overcrowded the mental training would not be lost, but would prove, as will all information or study, a valuable preparation for any business or calling.

NEW JOIST-BORING MACHINE.

One of the greatest difficulties which exist at the present time in the wiring of buildings, and one which causes the wiremen trouble untold, in addition to a considerable loss of time, is the boring of overhead timbers and joists for the

passage of wires. This trouble and loss of time is frequently so great as to increase the cost of installation by an appreciable percentage. An overhead joist-boring machine that is handled by the Metropolitan Electric Company of Chicago seems to meet this need. The illustration, which we have reproduced from the *Western Electrician*, shows the manner of application. This machine will, it is said, do about three times the amount of work a man can do without it, when he uses the ordinary angle brace, such as is customary with such work. At this rate a machine should pay for itself within two or three weeks' time very easily. This tool bores a hole of any size, and straight through the joist, thus greatly facilitating the stringing of wires, as when the hole is straight it does not necessitate the bend of the wire at each joist, and also prevents the liability of insulating tubes dropping out of the holes, as they frequently do when the holes are bored at an angle. The machine is also so constructed that it can be quickly adjusted to any width of space between the joists, and it allows the operator to stand in an easy, upright position, and does not require him to reach up over his head when using the machine. The bit, which is rigidly held in the chuck, can be easily removed when desired and a different sized bit inserted. The whole machine is substantially built for work, and there is nothing to get out of order about it. It is one that thoroughly commends itself to a workman.

THE THEORY OF CONSTANT SPEED DIRECT CURRENT MOTORS.

By W. G. RHODES, M.Sc., Royal Technical Institute, Salford.

It is of great importance that motors required for certain classes of work should be wound so as to preserve a speed as nearly as possibly constant under widely varying loads. This requirement is more or less perfectly met by the ordinary shunt-wound motor to an extent which depends upon the resistance of its armature and the degree of magnetisation of its field magnets.

It is possible, however, to compound motors so as to maintain a constant speed under all loads, up to a certain limit. The object of this paper is to investigate how this can be done.

We shall first conduct our calculations, neglecting armature reaction, and then correct for it in the final result.

We suppose the motor to be driven from some source of constant E.M.F., E, so that E is the constant difference of potential maintained between the terminals of the motor.

Let e = the counter E.M.F. of the motor;
i = current through the armature of the motor;
i^1 = current through the shunt coils;
r = resistance of the armature;
r_1 = resistance of the series windings;
r^1 = resistance of the shunt coils;
S = number of turns in series coils;
S^1 = number of turns in shunt coils;
τ = torque on the armature;
n = speed of motor in revolutions per second;
R = reluctance of magnetic circuit;
C = number of conductors on surface of armature;
F = total useful flux.

The following equations then hold good :—

The output of the motor = $e\,i$ watts and also equals $2\,\pi\,n\,\tau$,

therefore

$$2\,\pi\,n\,\tau = e\,i \qquad (1)$$

Also

$$E = e + i\,(r + r_1) \qquad (2)$$

$$e = \frac{n\,C\,F}{10^8} \qquad (3)$$

$$F = \frac{4\,\pi}{10\,R}\,(S\,i + S^1\,i^1) \qquad (4)$$

and

$$E = r^1\,i^1. \qquad (5)$$

Our object is to establish a relation between n and τ so that we have to eliminate e, i, and F from the above equations.

Combining equations (3) and (4) we get

$$e = \frac{4\,\pi\,n\,C}{10^9\,R}\,(S\,i + S^1\,i^1). \qquad (6)$$

Again, multiplying (2) by i, and substituting the value of $e\,i$ from (1),

$$E\,i = 2\,\pi\,n\,\tau + i^2\,(r + r_1). \qquad (7)$$

Also, substituting the value of e given by (6) in equation (2) we get

$$E = \frac{2\pi C n}{10^9 R}(S i + S^1 i^1) + i(r + r_1)$$

whence

$$i = \frac{E - \frac{2\pi C n S^1 i^1}{10^9 R}}{\frac{2\pi C n S}{10^9 R} + r + r_1} \qquad (8)$$

and, finally, by substitution of this value of i in equation (7) we are led to the equation

$$E\left(E - \frac{2\pi n C S^1 i^1}{10^9 R}\right)\left(\frac{2\pi n C S}{10^9 R} + r + r_1\right)$$

$$= 2\pi n r\left(\frac{2\pi n C S}{10^9 R} + r + r_1\right)^2 + (r + r_1)\left(E - \frac{2\pi n C S^1 i^1}{10^9 R}\right)^2 \qquad (9)$$

This is the required relation between n and r, and shows that if n is to be independent of r, that is, if the speed is to be independent of the load, the relation

$$\frac{2\pi n C S}{10^9 R} + r + r_1 = 0$$

must be satisfied; that is

$$S = -\frac{10^9 R (r + r_1)}{2\pi n C} \qquad (10)$$

The negative sign shows that the series coils must be wound in such a way as to oppose the shunt coils.

If equation (10) is satisfied, the speed is given by equation (9) which reduces to

$$n\left(E - \frac{2\pi n C S^1 i^1}{10^9 R}\right) = 0.$$

Neglecting the solution $n = 0$, we see that the speed is given by

$$n = \frac{10^9 E R}{2\pi C S^1 i^1}$$

$$= \frac{10^9 R r^1}{2\pi C S^1} \qquad (11)$$

since by equation (5) $E = r^1 i^1$.

Equating the values of $\frac{10^9 R}{2\pi C n}$ given by equations (10) and (11), we are led to the simple result,

$$\frac{S}{S^1} = -\frac{r + r_1}{r^1} \qquad (12)$$

That is (neglecting armature reaction), to compound a motor so that its speed shall be constant at all loads, the series coils must be wound so as to oppose the shunt coils, and the number of series turns must bear to the number of shunt turns the same ratio as the sum of the resistances of the series coils and armature bear to the resistance of the shunt coils.

This result is derived on the assumption that there is no armature reaction.

It is known that the field of a direct current motor is strengthened by armature reaction, so that to make our formula as correct as possible we must increase the number of series turns to the extent necessary to counteract the effect of the current in the armature. This we can do approximately as follows:—

Suppose that the brushes are set along the neutral line for sparkless running, and let λ be the angle of lead. The number of turns tending to increase the excitation of the field magnets due to armature reaction will approximately be the number of armature conductors included at any instant within an angle equal to 2λ. The total number of conductors round the armature is C, therefore the required increase in the number of turns is $\frac{2\lambda}{360} C$, λ being measured in degrees.

Equation (12) will, therefore, be more correctly written

$$S = -\left(\frac{r + r_1}{r^1} S^1 + \frac{\lambda}{180} C\right) \qquad (13)$$

and this may be taken as a working formula.

When using a compound wound motor care must be taken that the load does not become excessive, otherwise the machine will suddenly stop. This may be seen as follows:—

Eliminating e between equations (1) and (2) we are led to a quadratic equation in i, viz.:

$$2\pi n r = E i - i^2 (r + r_1)$$

or

$$i^2 (r + r_1) - E i + 2\pi n r = 0.$$

Solving this for i, we get

$$i = \frac{E \pm \sqrt{\{E^2 - 8\pi n r (r + r_1)\}}}{2(r + r_1)}. \qquad (14)$$

The current, i, must be real, therefore the expression under the square root must be positive, or, in the limit, zero; that is,

$$8\pi n r (r + r_1) \leq E^2,$$

or

$$r \leq \frac{E^2}{8\pi n (r + r_1)} \qquad (15)$$

Equation (15) shows that if the torque exceeds the expression there given the conditions of the problem are upset. This can only be if the motor comes to a standstill.

On this happening there will be no counter E.M.F. and consequently nearly all the current will go through the series coils and armature, with the result that the polarity of the field magnets will be reversed.

Equation (15) may be written in the form

$$2\pi n r \leq \frac{E^2}{4(r + r_1)};$$

that is, the maximum output, p, of the motor is given by the equation

$$p = \frac{E^2}{4(r + r_1)} \qquad (16)$$

This result is of interest, since it is similar to the expression for the maximum output of an alternating current synchronous motor,* and to that for the maximum power which a battery of constant E.M.F. can give to an eternal circuit.

Furthermore, the armature current corresponding to maximum output is from equation (14) given by

$$i = \frac{E}{2(r + r_1)} \qquad (17)$$

which is half the current the motor would take if the armature were at rest.

The corresponding value of the counter E.M.F. is given by

$$e = \frac{E^2}{4(r + r_1)} \times \frac{2(r + r_1)}{E}$$

$$= \frac{E}{2}. \qquad (18)$$

Referring again to equations (11) and (12), we see that when a motor is compounded for a certain (constant) speed, it is not compounded for any other speed, so that if the speed is by any means varied, it will not maintain that speed constant under a variable load. The specification of a compound-wound motor should, therefore, contain the speed at which it is to be run.

Current Corresponding to Maximum Electrical Efficiency.

The power supplied to the motor is $E i + E i^1$, and the output is $e i = E i - i^2 (r + r_1)$.

The electrical efficiency of the machine is therefore given by

$$\eta = \frac{E i - i^2 (r + r_1)}{E i + E i^1} \qquad (19)$$

which is easily proved to be a maximum when

$$i = \sqrt{\left\{\frac{E i^1}{r + r_1} + i^{1^2}\right\}} - i^1 \qquad (20)$$

* *Philosophical Magazine*, July, 1895. W. G. Rhodes "On the Synchronous Motor."

We may remark that the efficiency corresponding to maximum output is equal to

$$\frac{E^2}{4(r+r_1)} \times \frac{1}{E(\epsilon+i^1)}$$

$$= \frac{E}{4(r+r_1)\left\{\frac{E}{2(r+r_1)} + i^1\right\}}$$

$$= \frac{E}{2E + 4i^1(r+r_1)}$$

$$= \frac{1}{2 + \frac{4i^1(r+r_1)}{E}}$$

$$= \frac{1}{2} \text{ nearly,}$$

since the term $\frac{4i^1(r+r_1)}{E}$ is small.

Let us now illustrate the above theory by an example.

Suppose that a compound-wound motor is designed for a maximum output of 10 kilowatts on a 100 volt circuit. Let its speed be 1,200 revolutions per minute, so that $n = 20$.

By equation (18) the counter E.M.F. corresponding to maximum output is 50 volts.

By (16) we get

$$r + r_1 = \frac{10{,}000}{40{,}000} = 0\,25 \text{ ohm,}$$

and then, by (17),

$$i = \frac{100}{2 \times 0\,25} = 200 \text{ amperes.}$$

The maximum torque is, by (15), given by

$$\tau = \frac{10{,}000}{8\pi \times 20 \times 0{\cdot}25}$$

$$= 79{\cdot}5.$$

The useful flux is, by (3),

$$F = \frac{50 \times 10^8}{20\,C}$$

$$= 3{,}906{,}250$$

if we assume that $C = 64$.

Suppose, now, that $i^1 = 1$ ampere; then by (5)

$$\epsilon^1 = 100 \text{ ohms,}$$

therefore, by (12),

$$\frac{S}{S^1} = -\frac{1}{400}$$

If $S = 40$ turns, then $S^1 = 16{,}000$.

The reluctance is then found by (11) to be

$$R = \frac{20 \times 2\pi \times 64 \times 16{,}000}{10^{11}}$$

$$= 0{\cdot}0013, \text{ nearly.}$$

Again, the current corresponding to maximum electrical efficiency is, by (20),

$$i = \sqrt{\left\{\frac{100}{0{\cdot}25} + 1\right\}} - 1$$

$$= 19 \text{ amperes, nearly.}$$

The maximum efficiency is, by (19),

$$\eta = \frac{100 \times 19 - 19^2 \times 0{\cdot}25}{100 \times 19 + 100}$$

$$= 90{\cdot}5 \text{ per cent.}$$

The counter E.M.F. corresponding to maximum efficiency is, by (2),

$$e = 100 - 19 \times 0{\cdot}25$$
$$= 95{\cdot}25 \text{ volts,}$$

and the output, P, corresponding to maximum efficiency, is given by

$$P = 95{\cdot}25 \times 19 \text{ watts}$$
$$= 1{\cdot}81 \text{ kilowatts, nearly.}$$

The machine might, therefore, be used for a normal load of about 2 kilowatts.

To determine the maximum commercial efficiency we require to know the no-load current. As this depends upon the friction on the axle we will content ourselves with stating that the commercial efficiency is given by the expression

$$\eta^1 = \frac{E\,i - i^2(r+r_1) - p_o}{E\,i + E\,i^1},$$

which is a maximum when

$$i = \sqrt{\left\{\frac{E\,i^1 + p_o}{r+r_1} + i^{12}\right\}} - i.$$

THE THEORY OF THE WIRING TABLE.*

WIRES are used to form an easy and direct path for the distribution of the electric current, as pipes are used for distributing gas or water to places at a distance from the source of supply. The sizes of pipes are determined upon the basis of the distance and the quantity of material sent through them. Wires, as well, must have some distinct size depending upon the circumstance governing different conditions.

It is necessary to make calculations in order to ascertain the size of wire, and to shorten and to simplify this work of calculation wiring tables have been compiled. A wiring table gives at once the result in the commercial size of wire, and when the proper table is at hand no multiplying or dividing, no figuring, no application of a formula is required.

In all substances there exists some unknown obstruction to the flow of an electric current. The technical name given to this obstruction to the passage of an electric current is resistance. It is not known what causes this resistance, but by experiment the extent to which it exists in any substance can be ascertained and measured. It is known how in any substance the amount of resistance may be varied by altering the dimensions, also as to the amount of energy necessary to overcome any resistance.

The theory of the wiring table is simply one of proportioning resistances. The first point to be considered is how is the resistance varied in any substance? The law states that the resistance of any substance varies directly as its length and inversely as its cross-section. This law has been verified by experiment and is universally accepted as a law of nature.

The resistance varies directly as the length of any given substance means that if the length of a wire is doubled the resistance is doubled, and three times the length means three times as much resistance. The resistance varies inversely as the area of cross-section means that if the area of a wire is doubled, that is, if there is just twice as much metal for a given length of wire, the resistance is decreased one-half.

If the area is increased three times, the resistance is decreased to one-third. In a wire of a given substance, if the length is doubled, and at the same time the area is doubled, the resistance remains the same; or if the length is increased to three times as great, and at the same time the area is increased three times, the resistance remains the same.

From this application of the law already referred to it can be seen how it is possible to vary the size of a wire so that the resistance remains constant for any length, or how the resistance may be changed to suit any condition or circumstance.

The next consideration is the action of the electric current. The pressure is measured in volts, and the rate of flow is measured in amperes. The volts are all used up in forcing the amperes against the resistance. The resistance (if it were all in the wire) would mean a total loss of the electrical energy, because the volts would be used in doing work from which no results were obtained. It is necessary, therefore, to make the resistance of the wire which conducts the current but a proportion of the total resistance, the rest of the resistance of a circuit being that which exists in the lamps and the other devices or apparatus which convert the electrical energy into commercial forms, as light, power or heat.

To so compile a table and calculate the sizes it is necessary to consider the relation which exists between the unit of resistance, the ohm; the unit of pressure, the volt; and the unit of current, the ampere. One ohm resistance requires the pressure of one volt to transmit one ampere. Two ohms require two volts to transmit one ampere. One volt will transmit but one-half an ampere over two ohms, and 100 volts will transmit 10 amperes over 10 ohms.

This is Ohm's law, which, when given in the form usually found in text books, is as follows: The rate of flow, or current, measured in amperes, is equal to the volts divided by the ohms. The volts are equal to the amperes multiplied by the ohms, and the ohms are equal to the volts divided by the current flow or amperes.

Knowing the relation of resistance to the flow of currents and to the pressure, the next point to be considered is the substance used for the wires, and ascertain the amount of its resistance for a given length and size, to be used as a unit for making the calculation necessary in compiling the table.

Copper commercially and physically represents the best conductor for the transmission of the electric current. A dollar's worth of copper will conduct a greater amount of electric current than any other metal of equal value with the same loss of energy.

In the illustrations following, copper will be the substance considered, as the wiring tables used for ascertaining the size of wire are for copper wire. The units by which wire is measured are the circular mil and the foot. The circular mil is the area of a circle

* Paper read before the Chicago Electrical Association, by Thomas G. Grier.

whose diameter is one one-thousandth of an inch. The foot is a unit familiar to all.

The unit of wire then would be a wire one foot long, the area of which is one circular mil, and the resistance of this unit of copper wire is between 10 ohms and 11 ohms, depending upon the temperature of the wire.

10·6 ohms may be assumed as the resistance which approximates closely to the average at ordinary temperatures. Taking this as the basis for compiling a wiring table, it is known that to send an ampere through this unit of wire would require 10·6 volts. For, as stated in Ohm's law, the volts must equal the ohms multiplied by the amperes. But in every-day problems the known quantities are the volts and amperes, and the calculation is to find wires of proper resistance to suit the conditions.

The resistance, or the ohms, must equal the volts divided by the amperes. To solve this problem the volts are divided by the amperes, and we have the resistance. The resistance varies as the length and inversely as the area. It is the area of a wire which is desired, and one the resistance of which will equal the resistance found by dividing the volts by the amperes. The resistance of one foot of copper wire one circular mil in area equals 10·6 ohms.

The resistance of any wire is equal to its length multiplied by 10·6 and this divided by the area. Now it is known that the volts divided by the amperes equal the resistance, and the volts divided by the amperes are, therefore, equal to the length of the wire multiplied by 10·6 and divided by the area.

In any problem of wiring we have the number of volts and amperes, also the distance the current is to be transmitted, and the only thing remaining to be found is the area. To find this, we multiply 10·6 by twice the distance, or the total length of wire (in multiple arc work there is one outgoing wire and the return circuit, which makes the total length of wire double the distance), and multiply this by the amperes and divide the product by the volts used, which gives the area of the wire.

The volts used are not the total volts of the system, but the volts lost in the wire. If the problem is given so many per cent. loss, it would mean a per cent. of the total number of volts. To illustrate: If the wire is to use up two per cent. of the pressure, and the voltage of the system was 50, then you would divide by two per cent. of 50, or one volt, or, if the pressure was 100 volts, you would divide by two per cent. of 100, or two.

In compiling a table, let it be assumed for a 50-volt system for a regular increase of distances of 10 feet, the following method is pursued: First, the per cent. losses ascertained, let it be two per cent. This, then, would be one volt. Then one ampere will be considered, first, as the total current flow, and the following calculations would be made: 10·6 would be multiplied by 10 feet, and by two to get the length of the wire, and this multiplied by one ampere and the product divided by volts lost, or, in this case, by one, which would give us an area of 212 circular mils. This would be the size of a wire necessary to allow one ampere to be transmitted 10 feet with one volt loss (or two per cent. of 50 volts).

The next calculation would be for 20 feet distance, and as the resistance of the wire must remain the same, the area first found, namely, 212 circular mils, must be doubled as the distance has been doubled. For 30 feet to keep the resistance constant, the area is increased three times, and so on until the limit of the table, say 200 feet, is reached, when the area will be increased 20 times, as the length has been increased by that amount.

Then the same method will be continued for 2 amperes; namely, multiplying by 10·6 by the distance, and by 2 to get the length of wire, and this multiplied by amperes, and the whole divided by the volts lost. This is continued until the area for all the wires for each of the distances and for the various number of amperes has been determined.

As it is necessary to multiply 10·6 by the (distance multiplied by two) in every instance, 21·2 is used instead, and the straight distance used. The whole resolves itself into the simple formula:

$$\frac{21{\cdot}2 \times \text{distance} \times \text{amperes}}{\text{divided by volts lost}} = \text{area of wire.}$$

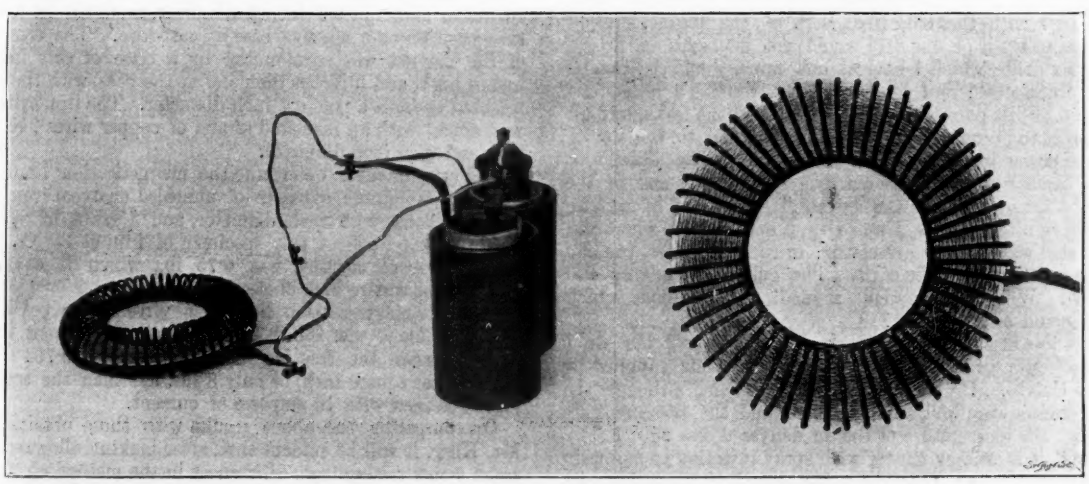
When these areas are found the commercial sizes of wire are inserted in the table which are nearest to the size found, but always larger, never smaller; that is, if the area found in the calculation came between a 0 wire and a 00 wire, the 00 wire would be the size used in the table.

CIRCULAR LINES OF FORCE.

By H. C. HAYCRAFT, B.Sc., A.I.E.E.

In a recent discussion in these columns a correspondent of somewhat revolutionary tendencies, while engaged in applying a torch to the foundations and superstructure of most of our well established ideas on electrical and magnetic matters, ventured *inter alia* to dispute the circular nature of the lines of force in a ring-shaped solenoid. Although the fact that the lines are circular should hardly require special demonstration at this stage of our electrical knowledge, it can, of course, be easily demonstrated by the use of iron filings, a method which has deservedly maintained its place as a most valuable means of mapping out magnetic fields, since its employment by Faraday in the inimitable "Experimental Researches."

The plate accompanying Faraday's paper dealing with this method (*Phil. Trans.* 1852, p. 158) gives admirable reproductions of a number of the results obtained with fields produced both by currents and by magnets. The particular case of the circular solenoid is not, however, included, and, so far as the writer can recollect, there is no illustration of this case in the text-books. In the recent edition of Prof. Ayrton's "Practical Electricity," there are some excellent illustrations of iron filing curves, including those produced by a circular coil of the tangent galvanometer type, but here, again, this case, though of some practical importance, has escaped notice.



The accompanying illustrations show the apparatus used by the writer, and the result obtained. The ring consists of a solenoid of 1½ inches diameter slipped over a split ring of white cardboard of 4 inches internal and 7 inches external diameter, and secured about a central strengthening disc of wood. A current of from 10 to 15 amperes passed round the solenoid produces a field quite strong enough to show the iron filing curves with great distinctness, and a view of the field so mapped, taken with the camera inverted, is shown in fig. 2, the circular character of the lines being unmistakable.

E

The photograph was taken on a Cadett ordinary plate, using three feet of magnesium ribbon at an average distance of 30 inches with stop 16.

The experiment is one that might usefully find a place in the first year laboratory, being of a simple, and, at the same time, decidedly instructive character.

CORRESPONDENCE.

Electricity v. Compressed Air.

I see Mr. Searing has fallen into the very common error of describing me as an "Air Man."

I am not the maker of any machinery, but a large user of it, and in that capacity I have sought to know, and think I have succeeded, in understanding the merits of all systems of transmitting power.

I am to-day using the endless running rope, hydraulic power, compressed air, and electricity, and in some cases I am using the petroleum engine in preference to transmission.

I know no one who, for 44 years in which I have been mining, has done so much in testing every apparatus employed.

All these systems have good points, and all have bad ones, and are suitable or unsuitable according to circumstances.

So far from being what he calls an "Air Man," I last week got above 7,000 tons of ironstone by rock drills of my own design, actuated by electricity, and if the stone had been equally good in all parts of the mine, the quantity would have approached 10,000, one drill in an 8-hour shift having got, including short work on Saturday, 1,241 tons for the week, and drilled 476 holes, 4 feet to 5 feet 6 inches deep. To show the fairness with which I treat these questions, although I have had the brake on one drill to test the H.P. I had in use, I have never attempted to get the useful effect compared with the indicated H.P. of the engine, simply because to try it on one drill would not be right, and to try it on six drills, which I have at one mine, would be practically impossible; but as I read Mr. Searing's letters, he stopped all his pumps but one, and allowed the leakage in all the pipes to go on, besides the loss incidental to the use of engine power in excess of requirements. "The amount of water discharged was measured by a weir at the end of the water discharge pipe on the surface." This was of no use, as I have often proved, a weir should only be used where you have still water, as in a reservoir; in running water, you can make anything you like of it. The gallons were only 400 (U.S.). Why not have made a small cistern, about which there could be no dispute?

The loss of effect from using only tanks to cool the air, I have often proved, but prefer to give the facts supplied by Prof. Unwin. He says:—"At Birmingham, although the compressors were well water-jacketed, and the pressure only 45 lbs., the temperature of the air delivered was 280° F."

Now, it is an easy matter with spray injection to maintain a temperature, or practically isothermal compression not exceeding 80°. The loss of compressed air by leakage in a coal mine is beneficial rather than hurtful, but leakage of electricity may be fatal; so the former gets little attention, whilst the latter is rigorously prevented—hence a common difference in the useful effect.

A. L. Steavenson.

There is a letter by Mr. Lewis Searing in your last issue, in which my name is used rather frequently as an advocate of compressed air transmission. I am no special advocate of compressed air as against electricity. There is a field for both modes of transmission. At the same time one may fairly object to the very gross misrepresentations of the efficiency of compressed air transmission in Mr. Searing's letter. If Mr. Searing has found an air plant having an efficiency of only 9 per cent., which is possible, it is only because in that plant every rule of construction which should have been observed was disregarded.

Mr. Searing states that he has yet to find a man who will show records of a compressed air plant where the efficiency is anywhere near 50 per cent. I will commend to his attention a very remarkable compressed air installation which is nearer to him than to me, namely, that erected at the North Star mine, Grass Valley, California, by Mr. A. de Wint Foote. The compressors are driven by Pelton wheels, and the compressed air is used to drive hoisting and pumping machinery in the mine. In a paper Mr. Foote has been good enough to send me details of the efficiencies of all parts of the plant are given. I need not quote these, as they have been published in America. But two sentences from Mr. Foote's paper will be the best answer to Mr. Searing's challenge :—

"The plain tale is this :—There is 304 theoretical horse power in the waterfall used at the power house, and the work actually accomplished at the mine amounts to 203 horse power."

"After nearly three months' working, the author believes the results obtained demonstrate the wisdom of having chosen air instead of electricity under the conditions."

Perhaps it is as well to add that Mr. Searing's statement, that the efficiency of a compressed air transmission diminishes with elevation is as erroneous as his other statements about compressed air.

W. C. Unwin.

Kensington, *February 22nd*, 1897.

On the Magnetisation Limit of Wrought-Iron.

In the current number of the Electrical Review I observe a brief notice of Mr. W. R. King's interesting experiments with a gigantic electro-magnet, in which it is stated that a record tractive force of about 400 lbs. per square inch was obtained.

As the determination of the magnetisation limit of iron is of considerable importance, I should like, with your permission, to direct attention to some experiments made by me in this direction, and described in the *Proceedings* of the Royal Society, Vol. 50, 1891.

My electro-magnet consisted of a cylinder of wrought-iron, 24 inches long and 3·5 inches diameter, mounted in a vertical position on a massive base of cast-iron. The free end of the magnet was surmounted by a cone of soft iron, 4 inches high, and 3 inches diameter at the base, with the apex rounded to form a pole 0·1 inch diameter. The iron cylinder was wound with an insulated strand of copper wires 950 feet long and 0·15 inch diameter.

The experiment to determine the magnetisation limit was made on a minute cylinder of annealed charcoal iron wire 0·2 inch long, 0·05 inch diameter, and $\frac{3}{4}$ grain in weight. The tractive force of this specimen of iron at 13° C., with 40 amperes of current, was 0·75 lb., which is equal to 381 lbs. per square inch of section.

That the magnetisation limit was virtually arrived at in this experiment was shown by reducing the current to 20 amperes, when the tractive force remained at 0·734 lb. = 373 lbs. per square inch, or only 8 lbs. less than the tractive force obtained with 40 amperes of current.

On comparing the above results with those obtained by Mr. King, it will be evident that, after making allowance for small errors arising from differences in the method of experimenting; the magnetisation limit of wrought-iron, as measured by the force of traction directly, is within 400 lbs. per square inch of section.

Henry Wilde.

February 22nd, 1897.

A Correction.

In an article in the issue of the Electrical Review for December 25th, 1896, on "The Validity of the Use of Sine Functions in Alternating Current Problems," I referred the reader to papers by Drs. Bedell and Crehore. Dr. Bedell informs me that the paper in the *Physical Review*, to which my article draws particular attention, is due to himself and Dr. Boyd. There is a further erratum which needs correction. Page 846, column 2, line 25, instead of *sine curves of equal area*, read: *sine curves having the same virtual values.*

W. G. Rhodes.

Since writing the above, I notice that Dr. Bedell has, in a letter to the Electrical Review for February 19th, drawn attention to the erratum relating to equivalent sine curves.

Micanite.

Under your "Business Notices" appearing in your issue of last week, you give publication to an extract of a communication which you have received from Mr. A. Norman, in which letter this gentleman would apparently discredit the veracity of the writer of the testimonial received by our friends the Mica Insulator Company from the Schenectady Railway Company. With every deference to the experience and knowledge of Mr. A. Norman, who styles himself a practical armature winder, we can only repeat your editorial remarks that the letter which you were kind enough to publish in your valuable journal was merely a copy of a testimonial which was received quite unsolicited by our friends over sea. Feeling, however, that the matter of the insulation of electrical machinery is becoming more and more important every day, and consequently that some definite and detailed reply should be forthcoming to Mr. Norman, we have written to America to ascertain whether there be any possibility of discrepancy or errors in the testimonial received.

In the meantime we would respectfully point out to your correspondent that micanite is in many cases furnaced before it is supplied, so that it is quite impossible either to burn it up or injure the cement with which it is manufactured. Mr. Norman evidently assumes that where heat is applied that the laminae of mica forming the micanite would fall apart; we may tell him for his information that this is not the case; but since our material is now used extensively in the manufacture of armatures to most of the leading electrical concerns in Europe and America, we cannot say that his apparent ignorance upon these points speak for his experience as an armature winder.

Bergtheil & Young.

February 18th, 1897.

Mordey's Inductor Alternator.

"X. Y." thinks it quite easy to "design" an iron cored alternator for a small drop; I quite agree with him. A great many iron cored alternators have been designed for a small drop; but they have always had a large one.

Perhaps if the designers, whose secrets are shared by "X. Y.," were to design a machine to have a large drop, they might get one whose volts rose with the load.

It is news to me that the large drop machines in general use were intended to be run on short circuit, and for that reason were given bad regulating qualities. I suspect this will also be news to their makers.

The general opinion is that an alternator should be capable of standing any occasional accidental, or even intentional short circuit without injury; if it will do this, and at the same time be a good regulator, so much the better.

W. M. Mordey.

London, *February 22nd*, 1897.

The Pioneer Enclosed Arc Lamp.

On my arrival in London last week my attention was called to the correspondence on the "Pioneer lamp," signed "Drake & Gorham," in your issue of the 12th inst. The remarks in question were called forth by an article which appeared in your issue of the 5th inst. on the "Marks Enclosed Long Burning Arc Lamp," generally known as the "Pioneer."

From the statements of Messrs. Drake & Gorham it would appear as though the "Pioneer enclosed arc lamp" were not, as its name truly indicates, the original, but merely an imitation of another make advertised by them.

As it is the intention of the Electric Arc Light Company, of New York, U.S.A., who own fundamental patents on the enclosed arc lamp on both sides of the Atlantic, to push the sale of these lamps on a large scale in Great Britain, I trust you will allow me to enter my protest against the statements of Messrs. Drake & Gorham, which, though undoubtedly made in good faith, are in many respects erroneous, and, in the main, misleading.

The "Pioneer" lamp has been acknowledged over and over again to be the standard enclosed arc lamp in America, and is recommended above all others by the leading central stations and isolated plants in the United States. In this connection it may be said that in the largest isolated arc plant in the world, consisting of nearly one thousand enclosed arc lamps in a single installation, the "Pioneer" is used exclusively.

As to the historical references in their correspondence of February 12th, I would respectfully refer Messrs Drake and Gorham to past publications and particularly to the introduction of a lecture delivered by me on January 20th, 1897, before the "Société Internationale des Electriciens," in Paris, on the subject of the "Enclosed Arc Light."

As to patent rights, I think the less said by Messrs. Drake and Gorham about them the better, as at the proper time and in a more appropriate place, should it be necessary, I shall have a good deal to say, which, for obvious reasons, it would be impolitic to state now.

Owing to recent simplifications in the lamp mechanism and the introduction of labour saving machinery, the company will soon be in a position to supply the public with "Pioneer" enclosed arc lamps at greatly reduced prices.

Thanking you in advance for your courtesy and trusting that I may have the honour to address you more fully in the near future,

L. B. Marks, M.M.E.,
Chief Electrician,
The Electric Arc Light Company, U.S.A.

Savoy Hotel, London.
February 24th, 1897.

Electricity Supply at 230 Volts.

I have to draw your attention to several inaccuracies in Mr. Gibbing's paper before the Northern Society of Electrical Engineers. The 3-wire system was complete throughout the town of Bradford in August, 1894, with the exception of a portion amounting to some 900 yards, and not half the town, as stated.

In regard to the wiring, "many of the worst had to be rewired before my advent." This, presumably, refers to the *five* consumers taken over from the Smith Douglas Company about 1891. Their premises were rewired, and made to comply with the rules before being connected to the Corporation's supply. Neither before nor after that date was any rewiring effected to my knowledge. The wiring was exceptionally well looked after, and inspected from the first, as the contractors occasionally found to their cost, the practice being in every installation to have one or two joints opened, in order to ascertain the soundness of the work before coupling to the supply. So carefully was the insulation question guarded, that all meters were placed on stands efficiently insulated with porcelain insulators.

Now, if the wiring had been so defective as is *ingeniously* set forth, how can it be explained that up to the time of my resignation there was not sufficient leakage *on the entire system at maximum load* to even redden the filament of an 8-C.P. lamp coupled from either pole direct to earth? These phenomenally excellent results for the first, and one of the largest, provincial central stations running successfully since 1889, were assuredly not obtained by the free use of cotton covered wire or other primitive accessories.

The double carbon arc lamp referred to will be found suggested by me in your issue of January 18th, 1895.

St. Pancras has been omitted from the list of high voltage examples. It may be of interest to state that the new works have been delivering into the distributing system *at 440 volts between the outers*, with consumers at 220 volts, very successfully for the past 15 months.

Sydney Baynes.

February 24th, 1897.

THIS YEAR'S MEETING OF THE BRITISH ASSOCIATION.

Mr. A. B. Macallum gives the following information in New York *Science* regarding the 1897 B.A. meeting:—

The local preparations for the meeting of the British Association for the Advancement of Science to be held this year in Toronto, commencing Wednesday, August 18th, have now after a year's work on the part of the various local committees reached a very advanced stage. The finance committee have been promised $27,500 to meet the expenses of the occasion. The sectional meetings are to take place in the buildings of the University of Toronto, which are cen-

trally situated, and which may be reached from all points of the city by means of the electric car system. As the university grounds are adjacent to the Queen's Park, and in the residential portion of the city, this arrangement will thus be a most agreeable one for the visitors. The Presidental addresses and the evening lectures will be delivered in Massey Hall, which has been recently erected and is capable of holding about 4,000 auditors.

Perhaps the most difficult of all the arrangements have been those pertaining to the matter of steamship and railway rates, but in these also very satisfactory progress may be reported. The British visitors will have reduced rates by the Canadian lines from Liverpool. The Canadian railways have made very important reductions to members of the Association who will travel in Canada between July 1st and September 30th. The Canadian Pacific Railway will give special rates also to members who wish to visit the North-west, British Columbia and the Pacific coast. A large number of special excursions have been organised, some of them to take place during the meeting, others immediately after its close. They will last from two days to three weeks, and as the weather will be cool, no doubt these trips will be exceedingly pleasant for the members. The retiring President is Lord Lister, President of the Royal Society. The President-elect is Sir John Evans, K.C.B., Treasurer of the Royal Society, who will deliver the Presidential Address on the evening of the opening day. The Council of the Association have chosen Presidents for the majority of the Sections. Those already appointed are:—Mathematics and Physics, Prof. A. R. Forsyth, M.A., D.Sc., F.R.S.; Chemistry, Prof. William Ramsay, Ph.D., F.R.S.: Geology, G. M. Dawson, LL.D., F.R.S.; Zoology, Prof. Louis C. Miall, F.L.S, F.R.S.; Economic Science and Statistics, Prof. E. C. K. Gonner, M.A., F.S.S.; Anthropology, Prof. Sir William Turner, LL.D., D.C.L., F.R.S.; Physiology, Prof. Michael Foster, LL.D., Sec. R.S.; Botany, Prof. H. Marshall Ward, D.Sc., F.R.S. Prof. James Dewar, LL.D., F.R.S., and Mr. J. Milne, F.R.S. (late Professor in the Imperial University of Tokyo) have been appointed to deliver the evening lectures. Amongst those who have promised to attend are Lord Kelvin, Lord Lister, Sir Henry Roscoe, F.R.S.; Sir Robert Ball, Profs. Viriamu Jones, LL.D., F.R.S.; G. Carey Foster, F.R.S.; J. S. Burdon-Sanderson, LL.D., F.R.S.; A. W. Rücker, Sec. R.S., J. R. Green, F.R.S.; F. O. Bower, F.R.S.; A. C. Haddon, D.Sc., C.: S. Sherrington, F.R.S.: A. H. Miers, F.R.S.; W. A. Herdman, F.R.S.; S. P. Thompson, F.R.S.; S. H. Vines, F.R.S.; A. G. Vernon Harcourt, F.R.S.; C. Le-Neve Foster, F.R.S.; Mr. J. Scott Keltie, W. H. Preece, F.R.S.; W. H. Gaskell, F.R.S.

BUSINESS NOTICES, &c

Electrical Wares Exported.

Week Ending Feb. 23rd, 1896.	£	s.
Albany. Teleg. mat. ...	374	0
Algoa Bay	124	0
Amsterdam	58	0
Brussels	594	0
Buenos Ayres	498	0
Calcutta	96	0
Cape Town	1,236	0
Colombo	20	0
Delagoa Bay	434	0
East London	1,126	0
" Elec. motors	1,362	0
Flushing	390	0
Gandia...	163	0
Hamburg	81	0
Malta	280	0
Melbourne	399	0
Monte Video	20	0
Norovissisk	37	0
Passages	230	0
Port Chalmers	1,012	0
Port Natal	35	0
Rio Janeiro	977	0
Total	£9,546	0

Week Ending Feb. 23rd, 1897.	£	s.
Alexandria	122	0
Amsterdam	45	0
Antwerp. Teleg. mat.	30	0
Auckland	80	0
Bangkok. Teleg. mat....	90	0
Bilbao	170	0
Bombay	139	0
Brisbane...	72	0
Buenos Ayres. Teleg.mat	76	0
Calcutta	300	0
Cape Town	484	0
Copenhagen. Teleg. wire	10	0
Durban. Teleg. mat. ...	151	0
East London	493	0
Gibraltar. Teleg. mat....	650	0
Gothenburg	26	0
Hamburg. Teleg. mat.	290	0
Hong Kong	247	0
Madras	71	0
Madeira	97	0
Malta	101	0
Passages	831	0
Port Elizabeth	109	0
Rangoon. Teleph. mat.	20	0
Rosario	50	0
Rio Janeiro. Teleg. mat.	350	0
Singapore	37	0
" Teleg. mat....	15	0
Sydney	1,246	0
Vera Cruz	60	0
Yokohama	361	0
Total	£6,863	0

Bankruptcy Proceedings.—The *London Gazette* contains notice to the effect that the first meeting of creditors in *re* Charles L. Clark, electrical engineer (carrying on business as the Northern Counties Electric Construction Company), of Newton-le-Willows and Manchester, will be held on February 26th (to-day) at 2.30 p.m., at the offices of the Official Receiver, Byrom Street, Manchester, and the public examination will take place on March 1st, at 11 a.m., at the Court House, Quay Street, Manchester.

Book Received.—"Elektrische Kraftübertragung und Kraftverteilung," by the Allgemeine Elektricitäts Gesellschaft, Berlin. Published by Julius Springer, Berlin.

Barlow v. Tyndale.—In the Westminster County Court, on Thursday last week, before his Honour, Judge Lumley Smith, Q.C., the case of Barlow *v.* Tyndale was tried. The plaintiffs, electrical engineers, sought to recover £28 from the defendant, a householder, for electrical work done at the Army and Navy Mansions, S.W. There was no dispute as to the work having been done, but defendant alleged that the landlord was to pay for the wiring, and the switches were included, but plaintiffs said the switches were not fittings, and defendant should pay this claim. His Honour expressed the opinion that the switches were included in the wiring, and there was no implied contract on his part to pay for anything. Plaintiffs should have given the defendant notice that he would be held liable. Judgment was given for the defendant, with costs.

Caught Napping.—We learn from the daily press that a labourer entered the premises of Mr. Wm. Cumby, stated to be an electrical engineer, at Wandsworth Common, and stole a good deal of jewellery and other property. After gathering his booty together he made himself comfortable in an arm chair and commenced imbibing the contents of a bottle of port. He was found asleep with the empty bottle before him, and was given in charge by the electrical engineer.

Dissolution of Partnership.—Messrs. G. Griffith and G. W. Clarke (formerly trading as electrical and cycle engineers at 84, Kirkdale, Sydenham), have dissolved partnership by mutual assent as and from February 1st.

Electrical Exhibition and Market.—During the first week in August (opening on the 2nd and closing on the 9th) there is to be held in the Agricultural Hall, Islington, a "Hardware, Machinery, Ironmongery, Inventions, Electrical and Allied Trades International Exhibition and Market," the aim of which is not merely to afford an entertaining and educational show, but to constitute a market, a display for purposes of trade. The electrical portion of the exhibition will be under the management of Mr. W. E. Aylwin, an experienced director of such undertakings, with the co-operation of Messrs. Dale & Reynolds, under whose management a series of nineteen annual Brewers' Exhibitions have been held with steadily increasing prosperity. The success of the forthcoming Electrical Exhibition appears, under these circumstances, to be assured, and manufacturers of fittings, domestic appliances, and such electrical goods as are stocked by the builders' or domestic ironmonger, would probably find it worth while to exhibit. The office is at 27, Leadenhall Street.

For Sale.—Messrs. Brett, Watson Co., of Manchester, are prepared to give particulars of the plant, machinery, stock-in-trade, &c., of Whitaker, Pollitt & Co., electrical engineers, 18 and 20, Blackfriars Street, Salford, which are being offered for sale by Mr. Arnold Watson, the trustee. See our "Official Notices" for further details.

Gas.—Gas explosions occurred at Morice Town, Devonport, on 19th inst., some buildings being wrecked. There was a large hole discovered in the gas main under the roadway.

On 15th inst. a gas explosion occurred in electric light culverts opposite the Music Hall, Aberdeen. Two covers were blown high in the air, but fortunately no one was injured. The pavement was torn up.

There was an explosion of gas on 22nd inst. at the Camberwell Provident Dispensary. A man was injured.

"H.M.S." Showrooms.—Messrs. H. M. Salmony & Co., of Charing Cross Road, have now completed the equipment of their large showroom for electric light fittings. The first floor of their premises, forming a room over 60 feet in length, is entirely devoted to the display of a great variety of work in brass, copper and iron, most of the fittings being made to the special designs of the firm. Some samples of electroliers and brackets in French styles, but made in England, are conspicuous. Novelties in plain and fancy glass shades are also shown adapted to every type of fitting, as well as the latest styles of shades in silk, beadwork, and other decorative material. The show is well worth inspection.

Lists.—Messrs. Alex. Turnbull & Co., of Bishopbriggs, Glasgow, have sent us a list of their patent accessible feed check and retention valves with removable seating for steam boilers, also their "*Sine qua Non*" junction and stop valves, which comprise safety and powerful opening and closing, and also removable free expansion seating.

An illustrated list of cast-iron flange pipes and connections has been sent to us by Messrs. John Shaw & Co., of Maryhill Ironworks, Glasgow.

Messrs. Nalder Bros. and Thompson, of Queen Street, E.C., have issued a new price list of N.C.S. patented brass-cased ammeters and voltmeters, resistance frames, automatic cut-outs, &c. Various illustrations are shown.

Magnolia Metal.—The Magnolia Anti-Friction Metal Company, of Great Britain, has sent us a 15-inch rule, which has a metal edging—we suppose of magnolia metal.

New Businesses.—Mr. Walter Scott, who has just relinquished his position as engineer in charge of Messrs. Crompton and Co.'s London house wiring department, on that firm giving up this branch of their business, gave a dinner to some 70 of their London works' staff at Queen's Gate Hall, South Kensington, on Saturday last, to inaugurate his commencing business on his own account. Advantage was taken of the gathering to present Mr. Scott with an illuminated address and handsome cruet, subscribed for by Messrs. Crompton's London works' staff. The dinner was followed by a smoking concert.

Messrs. Hale Bros. have commenced business at 18, Fenchurch

Buildings, and Sugar Loaf Court, E.C., as manufacturers of electrical apparatus. The partners are G. H. Hale and F. H. Hale, and we understand they have had many years' experience in electrical work.

Platinum in Russia.—Some interesting statistics with regard to the production of platinum in Russia were recently published by the Russian Minister of Finance. Russia holds the first place in the world as a platinum producer, her annual output being 40 times as great as that of all other countries combined. In 1880 the amount produced was 2,946 kilogrammes, and this had increased by 4,413 kilogrammes in 1895. The turn out has, in fact, continually increased, the only exception being that the figures for 1895 were less than the 5,028 kilogrammes of 1894, owing to the wet weather prevailing during the summer. The rare metal platinum is exclusively found in the South Oural. The uses to which it can be applied fail to create any demand for it in Russia, and it is exported in its raw state to Germany, where it is manufactured. The price has been very high during the last few years, and at present the kilogramme costs £45. Besides platinum, the much rarer metal, iridium, which is now extensively used, on account of its extreme hardness, in the manufacture of gold pens, is found, but in very small quantities. Last year only 4·1 kilogrammes, and in 1894 very little more was found of the latter metal.

Reconstruction.—For purposes of reconstruction the Crystal Electric Lamp Company, Limited, has resolved to wind up voluntarily, Mr. H. S. Deacon, St. Stephen's Chambers, Telegraph Street, London, E.C., being appointed liquidator.

Thetford Electric Light and Power Company.—As notified in our columns a week or two ago, the members of this company resolved to wind up voluntarily. A petition was presented at the Norfolk County Court on Thursday last week, before Judge Addison, Q.C., by Mr. Wm. Jackson, of Knotingley, a shareholder to the extent of £1,750, for the appointment of a liquidator by the Court. The Judge said the members of the company had passed a resolution for their voluntary winding up, and this could only be interfered with by the Court upon the grounds that something in the company's affairs required careful investigation. He could not find a suggestion of anything of the kind in the petition or the affidavits. The petition failed, and would therefore be dismissed with costs.

1896.—Mr. G. Braulik, of Upper Thames Street, E.C., states that business was very satisfactory in 1896, the general turnover showing an increase of about 50 per cent. on the previous year. The arc lamp sales (Korting & Mathiesen) greatly increased, and over 30,000 are now in use. The sales of their "London" incandescent lamps have been more than doubled during the year, and the increase of business has necessitated taking additional premises at Old Swan Lane. Showrooms are shortly to be opened.

ELECTRIC LIGHTING NOTES.

Belfast.—The Borough Electrical Engineer has verbally reported to the Electric Committee on the visit he has paid to electricity stations in Liverpool, Bradford, London, and Brighton, the chairman being with him at the two last-named. He is to prepare his report in writing.

Blackburn.—A deputation of tradesmen waited upon the Gas Committee of the Corporation on Tuesday in reference to the charges made for the electric light, urging that a reduction should be made, coupled with an abolition of the meter rents. The Committee promised to take the matter into consideration.

Blackpool.—The Town Council has resolved that in cases where private electrical plants are installed, and where the corporation's supply of electricity is used as a "stand by," the following shall be the terms upon which the supply shall be given:—For every unit of electricity which would be consumed in supplying the whole of the lamps and other electrical apparatus installed in any such premises during one hour, the sum shall be £9 10s. per annum, and in addition for every unit consumed as recorded by meter, the sum of 2d.

Bradford.—The Gas and Electricity Supply Committee will recommend the Council to extend the electricity supply to Heaton and Frizinghall, the cost being estimated at about £3,000.

Bray.—Mr. George M. Harris, electrical engineer, has received permission from the Commissioners to take one apprentice, and accept such fee as he might obtain, and he was also granted an increase of £47 a year in his salary.

Bristol.—The Sanitary Authority has agreed to the extension of the electricity mains to various specified streets of the city, involving the erection of about 200 more lamps.

The Bristol Ward Ratepayers' Association has resolved "that information be obtained as to the charge made for electric current in other towns and cities, and also as to where current is supplied both for purposes of lighting and for power."

Burton.—The New Street Baptist Chapel and Sunday School are to be wired for electric lighting at a cost of £170. Supply will be taken from the Corporation mains when they are laid in the Street.

Chester.—The Electric Light Committee has decided, subject to the Council's confirmation, to extend the electric light mains to Brook Street and Frodsham Street.

Cardiff.—At last week's meeting of the Electrical and Lighting Committee, Mr. N. Applebee, the electrical engineer, submitted his report. At the end of 1895, Mr. Applebee stated, there was an equivalent of 9,330 8-C.P. lamps connected to the system, and at the end of 1896 there were 14,136, showing an increase of 4,806. The returns of the amount of current supplied were also satisfactory. The units sold in the two years were 175,078 in 1895 and 306,450 in 1896, an increase of about 75 per cent. The current had been generated by the original plant, which had a capacity of 440 kilowatts. When the additional plant which Messrs. Ferranti and others were supplying was completed, it would remedy the somewhat overloaded state of affairs, but he considered it necessary to point out to the committee that if the applications for the supply of current continued to come in at the rate they had been doing in the past, the supply would be more than exhausted by the demand, and that, too, without allowing for any very large consumers, such as the new post office, or for electric traction purposes. The existing generating plant comprised four sets—two to supply 5,630 8-C.P. lamps each, and two to supply 1,250 8-C.P. lamps each, so that, estimating one large set to be held in reserve (as it should be), 8,130 lamps could be alight at once. By the addition of the new plant 13,860 lamps could be alight at the same time, and reckoning the proportion at about 80 per cent., this would really mean a total of 17,000. A small committee was appointed to go into the matter and to visit some works near Manchester to inspect certain plant in working order.

Chislehurst.—The *London Gazette* last Friday contained a copy of the application being made to the Board of Trade by the Chislehurst Electric Supply Company for electric lighting powers.

Colchester.—The Local Government Board has consented to the Town Council's proposal to borrow £15,000 for electric lighting. In regard to the ratepayers' memorial against the scheme, the Board see no reason for withholding sanction.

Colliery Lighting.—The Midland Coal, Coke, and Iron Company, Limited, Newcastle, Staffs., have installed another new electric lighting plant at their Podmore Hall Collieries, consisting of an Edison-Hopkinson shunt wound dynamo, giving an output of 350 amperes at 160 volts. The installation comprises 250 32-C.P. lamps for lighting of screens, slack washer, workshops, &c., and 12 Crompton-Pochin arc lamps for general lighting of waggon roads. The work has been practically installed by Mr. Arthur E. Andrews, senior electrician to the company.

Coventry.—The demand for electric light continues to rapidly increase. As soon as the present extension at the Corporation Electrical Works has been carried out, it is probable that a still further extension of plant will be required.

Douglas (I.O.M.).—A deputation from the Palace Company waited upon the Town Council the other day, and after stating that the company proposed to double their electric lighting at an increased expenditure of £400 a year, sought to ascertain on what terms the Council would allow the Tramway and Electric Power Company to lay a cable to supply the palace and other buildings *en route*.—A long discussion took place on the best means of lighting the town, and the majority seemed of opinion that the time had arrived when the question of adopting electric lighting should be seriously considered.—The Town Clerk was instructed to write to the Electric Power Company and the Gaslight Company, asking them to quote the prices at which they would undertake the public lighting undermentioned for 10 years:—(*a*) The Electric Lighting Company to provide 50 lamps of not less than 500 candles on the promenade; (*b*) an alternative, upon the basis that the supply mains would be laid and maintained by the Corporation; (*c*) the Gas Company to provide 120 double-C Welsbach burners of 60 candles; and (*d*) both companies to quote for light equal to 60 candles in all Corporation lanterns, except those on the Promenade.

Drumcondra and Clontarf.—The Township Commissioners of these two places are to confer together to consider the question of lighting the townships by electric light. A joint scheme is suggested.

Edinburgh.—In moving the reductions in the charges for current at Tuesday's Council meeting, Mr. Mackenzie said after the most successful first year's working of any electric lighting station ever started in this country, the company began the current financial year with 452 customers, and what was equivalent to 57,690 8-C.P. lamps. They were now within measurable distance of the end of the second year, and were able to estimate pretty nearly that on May 15th next they should begin the third year's working with 830 customers, having equal to 100,000 8-C.P. lamps joined on. The amount of light supplied during the current year shows an equally large increase, for while the number of Board of Trade units sold during 95/96 amounted to 888,335, the number of units sold during the current year ending May 15th next will amount to nearly, if not quite, 1,700,000—an increase of over 90 per cent. In regard to the financial results, they were equally successful. They would not forget that the price was reduced as from May last as from 6d. to 5d. per unit, continuing the large discounts as formerly. Meter rents were abolished, and public lighting Their income would be about £26,100, which was £2,250 above their estimate; their total expenses would be £19,250, which was, even with their much larger output, £950 less than the estimate, thus leaving the very handsome balance of £6,850 of income over expenditure for the year, instead of £3,650, as estimated. That was the result of this year's working, which the Council might take as practically correct, though there were yet a few months of the year to run. It was estimated that in the coming year the total output would not be less than 2,550,000 Board of Trade units, that being 45 per cent. increase. It might be a good deal more; he thought himself it would

be more like 60 or 80 per cent. of increase. The total costs for 2,550,000 units, including £16,135 as estimated by the Chamberlain for standing charges, the engineers put at £28,200. The total revenue they estimated at £32,120, counting the charge for private consumers at 4d. per unit with discounts, and the charge for public lighting at £16 per lamp, assuming that the number would be increased 80 or 90 lamps during the year. They thus contemplated a balance of income over expenditure for the year, after the present very large reduction in price, of £3,885, or, say, £4,000. It certainly would not be less; probably it would be £2,000 or £3,000 more. Regarding the public lighting, assuming that the council sanctioned an increase of 90 lamps for the year, and taking the number sanctioned already at 500, they might expect an average of 545 burning during the whole year, and for this they asked £16 per lamp, or a total of £8,720. For the up-keep of these 545 lamps they should have to expend £692 in carbons, £1,635 in trimmers' wages, and on repairs and maintenance £200, a total of £2,527, leaving them £6,193 for the current, sinking fund, interest, and management. The number of units required for the 545 lamps during the year was about 900,000; for this the committee got a little under 1¾d. per unit, £6,193 in all; while for the private lighting they got an average of about 3¼d. per unit, or, taking public and private lighting together, nearly 3d. per unit. This would show whether the electric lighting department was overcharging for street lighting. The reductions were unanimously agreed to.

Prof. Kennedy is to be asked to report to the Corporation Committee on the best means of introducing the electric light into Portobello. Information is to be obtained of the probable demand.

Fort William.—The Court House and prison buildings have now been lighted by electricity by the Fort William Electric Lighting Company.

Glasgow.—In reply to questions at the last meeting of the Corporation, it was stated by Mr. Maclay that the Electric Lighting Committee had not only been considering, but had been negotiating for the erection of, new works—much larger works than they had at present—which would enable them at a somewhat early date to supply current sufficient for the wants of the city for many years to come. When the arrangements were complete, not a moment would be lost in erecting the new works, not at one point only, but at two or three points. They already had in the city two storage batteries, which, while they would not generate current, would enable the committee to make a considerable addition to the supply, and help them to tide over the difficulty till the new works were erected.

The Corporation has adopted the recommendation of Mr. Arnot, the electrical engineer, to supply new customers with current at 200 volts.

Gorseinon.—This district is now lighted by electricity, 26 16-C.P. incandescent lamps being placed in the chief streets. The Electric Light Company has its expenses assured, we understand, by a number of local tradesmen.

Hackney.—The Baths Committee of the Hackney Vestry want an assistant electrician for the public baths at 35s. per week. See our "Official Notices" for further particulars.

Hammersmith.—In November last the Vestry fixed the charges for current at 6d. per unit for 2 hours per day and 4d. per unit beyond. It has now decided to adopt an alternative system, making a fixed charge of 1s. 3d. per 8-C.P. lamp per quarter, and 2¼d. per unit for all current consumed.

A staff is to be engaged for the generating station, at an estimated cost of £25 per week.

Hotel Lighting.—Messrs. Fippard & Cooper, of Bournemouth, are about to put down a plant for lighting Glasshayes Hotel, Lyndhurst, New Forest, with electricity.

Huddersfield.—The electricity accounts presented to the Town Council meeting last week, for the year ended December 31st, showed a balance of income over expenditure of £434.

Ilford.—The Ratepayers' Association recently requested the District Council to take the necessary steps to secure the lighting of the district by electricity. When the matter came before the Council it was referred to the Lighting Committee to investigate and report.

Kimberley (S. Africa).—The Town Council has adopted an electric lighting scheme for private houses and stores, at a cost of between £13,000 and £14,000.

Kingston.—The Town Council has increased the salary of its borough electrical engineer (Mr. J. E. Edgcome) from £200 to £300, the same to include his duties as consulting engineer. We congratulate Mr. Edgcome on the recognition that he has at last received. There was opposition to the resolution, but the voting was 18 in favour, and four against.

London.—We hear that Mr. F. J. Warden-Stevens has made an examination of the electric light installation at the Bishopsgate Institute, for the purpose of advising as to a means of reducing the annual cost, which is considered excessive. His report was before the Governors the other day.

Llandrindod Wells.—The electric lighting operations are progressing. The cables are now being laid.

Liverpool.—At the meeting of the Lighting Committee, on the 19th inst., the electrical engineer reported that the equivalent number of 16-C.P. lights connected with the supply mains on January 31st was:—For private lighting, 49,491; for Corporation lighting, 3,958; making a total of 53,449; being an increase of 959 on the month. The value of the electrical energy supplied during January was:—For private consumers, £6,503; for Corporation lighting, £234; making a total of £6,737; as against £5,401 for January, 1896. The value of the work executed by the manufacturing and fittings department during January was £524, compared with £468 in January, 1896.

Marylebone.—The Electric Light Committee reports that it has not yet come to a definite conclusion upon the subject of the Vestry lighting the parish by electricity, and recommends that the Paddington Vestry be informed that their proposition with respect to the lighting of Edgware Road cannot at present be entertained.

Newport.—A new sub-station, which has been provided in the basement of the Town Hall, to provide for the incandescent lighting of business premises and private houses, was informally opened on Monday last week. The new sub-station has three transformers, reducing the current from 2,000 volts to one-tenth of that number; a high tension switchboard, mounted with the necessary high tension fuses and switches, and a low tension distributing switchboard.

Norwich.—The price per unit has been reduced by 12½ per cent. by the Norwich Electricity Company, Limited, and the company offers to arrange special terms for motors.

Paris.—The Electric Light Committee held their second meeting last week at the Hotel de Ville, for the purpose of studying the proposals made by the different electric lighting companies respecting the prolongation of their contracts. The companies are willing to consent to a reduction in the price of the light, but, says the *Morning*, they have not yet given a reply to the proposition made on behalf of the workmen for them to participate in the profits when they exceed 6 per cent. on the original capital, as well as for other benefits that the Municipal Council seeks to obtain for the men.

Shoreditch.—The L.C.C. has sanctioned the Shoreditch Vestry electric lighting loans of £24,800 and £17,000.

St. Pancras.—The Vestry has accepted various tenders, amounting to £8,240 odd, in connection with the extension of the electric light in various parts of the district.

Stirling.—We understand that Prof. Kennedy, after visiting Stirling *re* electric lighting, considers that the proposal to utilise the Touch Water Works in connection with the scheme would not be practicable for several reasons. He questions whether sufficient water-power could be got all the year round, and raises other points of equal importance. His report will be submitted in due course.

Winchester.—The Electric Lighting Committee has approved of the deed for transferring the provisional order from the Corporation to the new company, and it will be submitted to the whole Council next week. In the event of the Council endorsing the report of the Committee, shares of the new company will be offered to the public.

Whitechapel.—The proposals of the County of London and Brush Company have already been referred to a committee, who are to confer with a representative of the company, but the Max-Saturn Electric Lighting Syndicate also have now sent in proposals, and these have likewise been referred to the Committee.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Birmingham, Wolverhampton, and District.—The Birmingham, Wolverhampton and District Tramways Bill, which will, it is expected, be introduced into Parliament in the form in which it was originally deposited, seeks (says the *Financial Times*) powers to incorporate a new company, of which the first board of directors will comprise Sir Charles Rivers Wilson, the Earl of Suffolk and Berkshire, Sir Charles Fremantle, Mr. John Smith Raworth, and Mr. Emile Garcke. Upon this company it is proposed to confer powers to acquire the undertakings of the Dudley and Stourbridge Steam Tramways Company, Limited, the Dudley and Wolverhampton Tramways Company, Limited, the Wolverhampton Tramways Company, Limited, and a part or the whole of the system of the South Staffordshire Steam Tramways Company. In connection with these systems, it is proposed to construct over 18¾ miles of new lines, which, according to the deposited estimate of the engineer, will cost £140,452, which includes £1,000 for the land and buildings required for a generating station at Dudley Port. In addition to these extensions, Parliament will be asked to grant running powers to the company over so much of the tramways of the South Staffordshire Company as may not be transferred to them; so much of the tramways of the City of Birmingham Tramways Company as lies between the termination thereof in Handsworth and Colmore Row, Birmingham, and over the tramways of the Birmingham and Midland Tramways Company, Limited. The share capital proposed to be raised by the company for this scheme is £799,000, with power to borrow on mort-

gage a further sum of £199,750. The capital will be divided into £10 shares, with power to divide them into "preferred half shares," and "deferred half shares."

The Wolverhampton Council had the company's proposals before them last week, and decided that as the promoters had failed to agree to the Tramway Committee's terms, they could not give their consent to the Bill. The General Purposes Committee of the Dudley Council have consented to the Bill, subject to certain modifications.

Brisbane.—We learn that the Brisbane Tramways Company have made steady progress with the buildings in Countess Street, which are to be used for the business offices, car sheds, and power station in connection with the lines they are now equipping for electricity. The *Brisbane Courier* gives the following particulars:—The building to accommodate the engines and dynamos is being built of brick, is stoutly founded, and when completed will be a substantial and massive structure. Three engines capable of working up to 450 H.P. each will be erected, and space is being retained for a fourth. Similar provision is to be made for dynamos, and great care is being bestowed on the preparation of concrete beds for this machinery. The plant which the company intends putting in is by far the largest in Australasia. At the rear of the power station a shed, designed to accommodate the cars, stands partly erected. The trams will be run in here off the tracks on to rails built on piers, so that operators may easily get beneath them should repairs be required to the machinery. This building is very commodious, and should admit pretty well all the cars in the city. Other buildings of a similar character will, however, be erected in other parts of Brisbane. The public and private offices of the company are very roomy. The bulk of the machinery of the plant has been delivered in Brisbane, and several of the heavier parts of the engines and dynamos have been carried to the grounds. "It is understood that the laying of new tracks will be supervised by an officer of the company, who is coming from America specifically for that purpose."

Calcutta.—The Calcutta electric tramway scheme still hangs fire. The proposals of the General Committee of the Municipal Commissioners, to accept Messrs. Kilburn's scheme, have several times been referred back, and a committee was last month appointed to thoroughly investigate the question of mechanical traction for Calcutta. It is also stated that Messrs. Kilburn have now withdrawn their offer to relay the lines and equip them electrically.

Cardiff.—A deputation from the Tramways Committee is to visit some works in Lancashire, for the purpose of inspecting the model of a tramway worked by electricity, with a view to introducing electric traction into Cardiff.

The special committee appointed by the County Council to consider the advisability of establishing a system of electric tramways in various parts of the borough met for the first time on 17th inst., and several routes were mentioned as desirable.

Douglas (I.O.M.).—The Highways Committee has before it an application from the Douglas Head Electric Tramway for leave to extend the line along the inner side of the Head to the Castletown Road, and thence by the bridge and quay to the Victoria Pier.

Dover.—Messrs. Dick, Kerr & Co., Limited, of 101, Leadenhall Street, London, and Britannia Engineering Works, Kilmarnock, have inaugurated their new electrical traction department by securing the contract for the electrical equipment of the Dover Corporation tramways. The following is a list of the tenders which were sent in for the electrical equipment, Mr. Sellon's (the consulting engineer) estimate being £11,000:—

	£	s.	d.
R. W. Blackwell	13,000	1	5
Brush Electrical Engineering Company ...	13,679	5	0
Siemens Bros.	12,432	8	0
Dick, Kerr & Co. (accepted)	8,040	0	0
Westinghouse Electric Company	11,718	5	0

Isle of Man.—It is stated that the Isle of Man Tramways and Electric Power Company intend to apply at the Tynwald Court for a Bill to empower them to extend their electric system from their Laxey terminus to Ramsey. For this large extension new capital will be required.

Leeds.—We understand that satisfactory progress is being made with the electric tramway from Kirkstall to Roundhay. The Tramways Sub-Committee made its usual monthly inspection on the 16th inst.

North Staffordshire.—On 18th inst. the Light Railway Commissioners held an inquiry at the Newcastle-under-Lyme Town Hall into the application of the British Electric Traction Company for an order to authorise the proposed Potteries Light Railways. The Commissioners were the Earl of Jersey, Colonel Boughey, and Mr. Fitzgerald, the secretary of the Commissioners being Mr. Bret Inge. Mr. Sydney Morse (London) opened the case for the promoters, and pointed out that the scheme was a very important one, and had received a great deal of local support from the various authorities of that very populous district. The gauge was a 4-foot one, this being fixed by reason of the fact that the other similar tramway lines were upon that gauge, and it was desirable that the gauges should be identical. They asked for power to use animal, electric, or other mechanical powers; but it was proposed to work the system by the electrical overhead system. The result of the construction of these light railways would be that there would be a continuous service of trams or light railways between Blyth Bridge and Fenton on the south, and Goldenhill on the north, with branches at Newcastle, Stoke, Chesterton and Silverdale. Mr. Morse first called Mr. George C. Kent, Town Clerk of Longton, who gave evidence strongly in support of the lines from Blyth Bridge and from Trentham to Longton, which had been unanimously approved by the Longton Corporation. Mr. S. Sellon, engineer, was the next witness, and gave evidence at great length. He was questioned by Mr. Godfrey as to the application of the promoters for compulsory running powers over the existing North Staffordshire Tramways Company's lines. He admitted that these lines were practically extensions of the North Staffordshire Tramways Company. It had been understood that the latter company should have something to say as to the management of these lines, and what they were prepared to do under the order. They could not obtain compulsory powers under a provisional order under the Tramways Bill, but could do so under the new Light Railways Act. Lord Jersey announced that the Commissioners would not give compulsory running powers, but would not object to any agreement arrived at between the promoters and the North Staffordshire Tramways Company. Mr. Emile Garcke, managing director of the promoting company, having given evidence, Mr. Blakiston said he did not appear as an opponent of the scheme, but the Staffordshire County Council desired to see that the cost of the maintenance of the roads was not increased, and that the safety of the public on the roads was not interfered with. He pressed the necessity of kerbing and channelling on one side of the road, even in rural roads, where such lines went. Lord Jersey thought this a rather extreme demand. Mr. Morse said if that were insisted upon, he was afraid the promoters would have to withdraw their scheme. This was the last straw which would break the camel's back. Lord Jersey said he should require extraordinary evidence to induce him to think it necessary to kerb and channel the roads in rural districts, or to call upon the promoters to do so. Mr. Fitzgerald expressed his agreement with Lord Jersey in this matter. In replying on the case, Mr. Morse pointed out that of the 15 local and road authorities affected, not one now opposed the scheme of the promoters. Lord Jersey said the Commissioners were unanimously of opinion that the order should go on. He need hardly point out that a good many clauses had to be settled and drawn up. It must be dependent upon those clauses being satisfactorily drafted and meeting the approval of the different parties. Mr. Morse said he did not anticipate any substantial difficulty now that they had got the principles admitted between them. If they got into any difficulty, might they ask for his Lordship's good offices. Lord Jersey: We will do our best to bring the parties together.

At the meeting of the North Staffordshire Tramways Company, held in London on Tuesday, the chairman stated that a large amount of material for the electrical equipment of the line was ready, and they hoped if the negotiations could be brought to a satisfactory conclusion, the line would be electrically equipped within a short time.

Roumania.—It is stated by a financial contemporary that the Town Council of Jassy intends to float a loan of 5,000,000 francs for the electric lighting and tramways of the town.

Speed of Electric Cars.—In consequence of the many complaints which have been made about excessive speed on the Dublin electric tramways, and particularly the complaint of the Dublin, Wicklow, and Wexford Railway that the speed of the Dublin United Tramways between Dublin and Dalkey was excessive, a Board of Trade inquiry was held the other day at the offices of the tramway company. The railway company declared that sometimes the speed of the cars was 12, 14, and 15, and once 19 miles an hour. Evidence was given by witnesses on both sides, some showing that the speed did not exceed eight miles an hour, others saying that they had witnessed the cars going at much higher speeds. A great deal of evidence was produced by the various parties interested, and the inquiry closed.

Torquay.—A scheme has been propounded for establishing an electric tramway between Torquay and Paignton. Messrs. Massingham & Mann, electrical engineers, and a legal firm, have the matter in hand, and it is currently reported that a syndicate is about to be formed with a view to obtaining the necessary powers and carrying out the scheme. It is proposed to construct a tram line from the Strand along the Torbay Road to Paignton, and eventually to connect Tor Station and the Strand by a similar line.

Tramway Financing.—The *Financial News* says that the Banque Française de l'Afrique du Sud intends, it is rumoured on the Paris Bourse, to amalgamate with a Paris establishment. This bank has participated already with the Comptoir National in the reconstruction of the Compagnie Générale de Traction, founded especially for the purpose of establishing electric tramways. The company, the capital of which amounts to 17,500,000f., in 175,000 1,000f. shares, is connected with the working of already existing lines, and has concessions for several towns in France and abroad, amongst the latter Alexandria.

TELEGRAPH AND TELEPHONE NOTES.

A Cable Map.—What would have been a very useful map had it had proper technical supervision before issue, has just been issued by Mr. Henry Sell. Its object, so far as can be learned from a map containing many errors and omissions, is to show how to travel or cable to any part of the British Empire. It is dated 1897.

Explosion on a Cable Ship.—The *Pouyer Quertier* put into New York on February 9th for repairs which were said to be necessitated by the bursting of a boiler, causing the death of one fireman and injuries of a more or less serious nature to several others, including an engineer.

Brisbane Telephone Service.—We stated quite recently that Mr. John Hesketh was to report on the telephone service of Melbourne. We also now observe from the *Brisbane Courier* that he has given special attention to the Brisbane telephone system and upon his recommendation the underground metallic circuit system is to be adopted, and the necessary material ordered. Last year out of a total of 3,519 faults, 2,858 were instrument faults. The instruments hitherto used have been of a variety of types and patterns, and have all been the property of the subscribers, they having purchased them from local dealers. This the Postmaster-General has decided to alter. In future all instruments will be supplied by the department, and therefore the responsibility of the whole system will be theirs. Local dealers may consider themselves aggrieved, but it is urged in reply that the fault has been in permitting them to interfere in the past—not in preventing them in the future. We understand that the instruments ordered from home are of the English Hunnings type. The rates will be £6 per annum for the first half-mile, and 25s. for every additional half-mile, including wire and instrument. The rates for call office communication have been reduced to 3d. for three minutes, and a system of telephonograms introduced. Trunk lines are contemplated between any two towns possessing exchanges.

New Switchboard.—On February 18th a public trial took place at the works of Messrs. Pullin & Shore, electrical engineers, Bolton, of a new telephone switchboard, of which Mr. Shore is the inventor. A feature of the invention is that the use of cord attachments is entirely dispensed with.

River Plate Telegraphs.—The *Financial News* commissioner at Monte Video, wiring on the 19th inst., said:—"The trouble between the River Plate Telegraph Company and the Argentine Government is not yet settled. The company now states that it will institute immediate proceedings against the Argentine Government for what it considers to be an unwarrantable interference with its operations. Heavy damages will be claimed, as the office has now been closed for some time by order of the Government." This trouble between the South American cable companies and the Governments of South American States appears, says our contemporary, to have had its origin in the following manner:—The Western Brazilian Company has been enjoying a monopoly of telegraph communication on the coast of Brazil, the concession running until 1913. This telegraph line is connected with the city of Buenos Ayres by lines operated by the River Plate Telegraph Company of Monte Video. In order to prevent competition in business destined for the United States and Europe, an overcharge of 50c. in gold per word has been imposed on telegrams *viâ* Galveston to Brazil since the year 1892. Representations to the different Governments concerned produced no effect until last June, when the Argentine Government ordered the River Plate Telegraph Company to stop collecting this overcharge in Argentine territory. Protests and proposals of arrangement followed, all tending to prevent the interference of Argentina, until October, when the Government of Argentina gave the River Plate Telegraph Company 24 hours in which to comply with its decrees. The Governor sent a representative to the office of the River Plate Telegraph Company to prove that violation was being insisted upon, and at 3 o'clock stopped the service here because of the alleged evidence of insubordination. Since then the River Plate Telegraph Company has inquired of the Government concerning the terms under which the reopening of its office would be permitted, and the Government has replied that only on unconditional surrender without any reserve, expressed or implied, would the company be allowed to continue its business.

River Plate Telephones.—According to a River Plate exchange the United River Plate Telephone Company has completed its metallic circuits to the Gran Dock at Ensenada. The company has also opened a branch office at San Martin, and metallic circuits with transformers have been erected between the central office and the new exchange. All the instruments are fitted with Delville microphones.

Telegraph Rates to India.—The Report of the Indo-European Telegraph Department for the past year shows very satisfactory financial results. Our readers will remember that it is this Government Department which controls the lines from India through the Persian Gulf, and as far as Teheran, where the landlines of the Indo-European Telegraph Company are met; by means of which messages from India are carried to Europe, thus forming an alternative route to the cables of the Eastern Telegraph Company. We do not take into consideration the Turkish route which is so frequently interrupted, having been useless for 111 days last year. The earnings of the Indo-European Government Telegraphs for the last year amounted to Rs.1,670,081, being an increase of Rs.99,661 as compared with 1894-95. The expenditure amounted to Rs.817,450, being a decrease of Rs.9,447. The profit accruing is therefore Rs.852,631, as against Rs.743,523 in the previous year. The steady growth of profit during the past five years is shown by the fact that in the year 1891-92 the net earnings only realised Rs.162,034. The dividend on the large capital was nearly 7½ per cent., and the secretary of the Public Works Department, in reviewing the report, pertinently observes that when the profits are so large, the question of reducing the rate for messages deserves renewed consideration. The representatives of the Indian Government advocated such a reduction at the International Telegraph Conference at Buda-Pesth last year, and they were backed by the British delegates. Strong opposition was, however, raised by the Eastern and Indo-European Companies, and for the present the matter remains in abeyance, but the department intends to bring it forward again. We trust that their efforts will be successful, for the present rates press heavily upon commercial men in India. It is worth noting, though, that the Pacific Cable Commission has at last reported in favour of a speedy completion of the proposed trans-Pacific cable from Vancouver to Australia. When this cable is laid, it may have some effect upon the payments now made under the agreement relating to the Australasian Message Fund. As the Indo-European Government Department are satisfied to forego a portion of the profit they are making for the advantage of the Indian public, it is to be hoped that they will be ultimately successful in persuading the Eastern Telegraph Company and their friends, the Indo-European Telegraph Company, to agree to the reasonable demands which are being made for a reduction of the rate to India.

Telegraphic Communication with the West Indies.—The following is a copy of a memorial from the Board of Trade, Halifax, N.S., to the Government of the Dominion of Canada, dated February, 1897:—"The Board of Trade of the city of Halifax, Nova Scotia, representing mercantile interests in the community, beg to submit a memorial to the Government on better telegraphic communication between Canada and the West India Islands. The necessity of immediate action in this great question is very urgent. Your memorialists are of the opinion that the present cable communication is unsuited for the full development and proper direction of the resources of Canada. It is possible that the trade will revive between the West Indies and Canada, in view of Imperial assistance to the West India planter. One great means of accelerating this trade, and of binding the Colonies together, is within the reach of the Dominion and Imperial Governments. It is the extension of the existing cable to Bermuda. We would respectfully urge that the Government render every assistance to the Halifax and Bermudas Cable Company, Limited, who will undertake, with the necessary assistance, the extension of its cable from Bermuda to the other West India Islands. At the same time giving the mercantile community and others the advantages of a much cheaper and more direct telegraphic communication than now exists.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1895 ...	...
West Indies—		
Puerto Plata-Martinique	Dec. 19th, 1895 ...	...
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	...
Grenada-Trinidad ...	Feb. 4th, 1897 ...	...
Jamaica-Colon	Feb. 6th, 1897 ...	...
Delay to Trinidad and Demarara 12 to 15 hours.		
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Hong Kong-Macao	Jan. 5th, 1897 ...	...
Pernambuco-Ceará	Feb. 4th, 1897 ...	...
Assab-Massowah	Feb. 20th, 1897 ...	...
Telegrams are forwarded by boat.		
Landlines.		
Trans-Continental line beyond Masol	March 12th, 1896 ...	...
Salisbury-Umtali	July 11th, 1896 ...	...
Carthagena - Barranquilla (Columbia)	July 4th, 1896 ...	...

The New French Trans-Atlantic Cable.—The construction of the cable which La Compagnie Francaise des Câbles Télégraphiques has undertaken to lay between Brest and New York under a contract with the French Government, is being rapidly pushed forward. The core is being made at Bezons and sent on to the works at Calais, where the sheathing is effected. We understand that the core will be of about the same dimensions as that used in the last Anglo-American cable, viz, 650 lbs. of copper wire and 400 lbs. of gutta-percha insulation per nautical mile. The total length of the cable when laid is expected to be about 3,250 miles, and the total weight is estimated at nearly 11,000 tons. This, when completed, will be the longest submarine cable yet laid, and will be only about 200 miles less in length than the proposed cable in the Pacific from Vancouver to Fanning Island, which has been the subject of so much adverse criticism in certain quarters. The depth of water through which the French cable will have to pass will be greater in places than that portion of the Pacific line above referred to. It is hoped that Brest and Cape Cod will be directly united by the new cable in the course of the coming summer, and this cable, which will form an alternative to that recently acquired by the French Company, may be expected to have a carrying capacity of about 18 words per minute. Under the terms of their contract with the French Government, the French cable company receive an annual subsidy of £32,000 for a period of 30 years, and, pending the duration of the agreement, the French Department of Posts and Telegraphs undertakes to give preference to the new company for all telegrams of which the sender has failed to designate the "*via*," and, on the other hand, the company will (in default of another "*via*") pass over its own lines all messages collected by it at all points served by its cables and addressed to Europe, or passing over the European system. By this arrangement the French Government will benefit by the traffic thus secured for its landlines. In short, the company will act as collectors for the benefit of the French Government on the one hand, and the French Government will act as collectors for the company on the other hand.

The *Financial News* says that the new cable will measure not less than 3,250 miles, or more than 6,000 kilometres. The manufacture of the conducting portion itself, which will consist of 13 strands, will consume 975,000 kilos. of copper, and 845,000 kilos. of raw India-rubber will be used as a covering. The total weight of the 3,250 miles of material will be something like 10,976,350 kilos. Four vessels of considerable tonnage will be required to transport and place it, and it is hoped that the immersion will be commenced early in the summer.

CONTRACTS OPEN AND CLOSED.

OPEN.

Ashton-under-Lyne.—March 15th. The Corporation want tenders for the supply and erection of refuse destructors, boilers, dynamos, transformers, cables, lamps, accumulators, &c. Consulting engineers, Fawcus & Clirehugh, Temple Chambers, Brazennose Street, Manchester.

France.—February 27th. The Seine Prefectural Authorities in Paris are inviting tenders for the concession for the electric lighting of the Broca Hospital during a period of 10 years. Tenders to the Prefet de la Seine, Tribunal de Commerce, Paris.

France.—March 4th. The French Post and Telegraph Authorities in Paris are inviting tenders for the supply of 235 tons of copper wire in nine lots. Tenders to be sent to the Sous Secretariat d'Etat des Postes et des Telegraphes, Rue de Grenelle, 103, Paris.

France.—March 9th. Tenders are being invited by the French Post and Telegraph Authorities in Paris for the supply of 122 kilometres of paper-insulated electric cables, in two lots. Tenders to be sent to the Sous Secretariat d'Etat des Postes et des Telegraphes, Rue de Grenelle, 103, Paris.

France.—March 10th. Tenders are being invited for the contract for an installation of electric lighting in the Asile Departemental d'Aliénés du Rhône, at Bron. Tenders to be addressed to the Préfecture du Rhône, Lyons.

Germany.—The Telegraph Department of the Saxon State Railways in Dresden is inviting tenders until March 10th for the supply of 3 tons of bronze wire, 60 tons of galvanised iron wire, 10 tons of copper wire, 16,500 porcelain insulators, and 12,000 zinc cylinders for primary batteries. Tenders to the Kgl. Betriebs-Telegraphen Ober-Inspection der Sachs, Staatseisenbahnen, Strehlenerstrasse, 1*a*I, Dresden.

Glasgow.—Tenders are being invited for the supply and fixing at the Olympia, New City Road, Glasgow, of one 25-H.P. gas engine, 20-2,000 candle-power arc lamps, and some incandescent lamps, and wire, cable, switches, etc. Tenders to be sent to Mr. E. H. Bostock, care of Lithgow & Son, printers, 76, West Howard Street, Glasgow.

Jamaica.—April 15th. The Privy Council invites applications for a license for the establishment and working of a system of rapid transit in Kingston and environs. Copies of the Tramways Law, 1895, and of local rules and maps of Kingston and environs may be seen at the offices of the Crown Agents for the Colonies, London.

Morecambe.—The District Council is inviting tenders for the supply and erection of boilers, dynamos, mains, transformers, accumulators, arc lamps and posts, testing apparatus, &c. See our "Official Notices" for further details.

Plymouth.—March 26th. The Corporation is inviting tenders for alternators, dynamos, boilers, condensers, pumps, accumulators, cranes, switchboards, mains, conduits, transformers, arc lamps and posts, and various other apparatus and machinery in connection with the electricity works of the Borough. Borough Electrical Engineer, Mr. J. H. Rider. See our "Official Notices" for more detailed particulars.

Roumania.—March 15th. The Municipal Authorities of Braila, Roumania, are inviting tenders for the concession to construct and work during a period of 35 years, of a system of electric tramways in the town. Tenders may be submitted for either the accumulator, electro-magnetic, or overhead-conductor systems of traction. Particulars from and tenders to La Mairie, Braila, Roumania.

Spain.—Tenders are at present being invited by the General Direction of the Spanish Post and Telegraphs in Madrid, for the supply of 42,000 porcelain insulators and 24,000 telegraph poles. Tenders to be sent to El Registre de la Direicion General de Correos y Telegrafos, Calle de la Carretas, 10, Madrid.

Spain.—March 12th. The Municipal Authorities of Bailen (Jaen province) are inviting tenders for the concession for the electric lighting of the town during a period of 10 years. Tenders to El Secretario del Ayantamiento de Bailen (Jaen).

Tunbridge Wells.—March 13th. The Corporation want tenders for the supply and erection of a 350 kw. alternator with engine combined. Borough engineer, Mr. Boot. See our "Official Notices" for further details.

CLOSED.

Blackwall Tunnel.—The London County Council on Tuesday accepted the following tenders in connection with the electric lighting of the Blackwall tunnel:—Messrs. Laing, Wharton & Down, wiring, &c., £4,700. Edison & Swan United Electric Light Company, supply of lamp boxes, 19*s.* 6*d.* each, also the supply of lamp holders at 1*s.* 8*d.* each, lamps at 1*s.* 10*d.* each, and globes and holders for the lamps in the tunnel at 3*s.* 6*d.* each. Messrs. Nettlefold, for the supply of bolts and nuts required in connection with the lighting, at prices varying from £3 8*s.* 6*d.* to £5 3*s.* 6*d.* per gross. Messrs. Macfarlane, supply of the necessary lamps and lanterns in the open approaches to the Blackwall tunnel at £6 15*s.* 6*d.* each for 30 straight columns and lamps, and £20 17*s.* 6*d.* each for 4 triple-armed lanterns.

Brighton.—The Council has accepted the tender of Messrs. Willans & Robinson, to supply and erect at the electricity works two 750 H.P. engines with dynamos of the Electric Construction Company's make attached thereto, for the sum of £9,576.

Hammersmith.—The Vestry has decided upon the recommendation of the Electric Lighting Committee to purchase 20 electricity meters from each of the following firms:—British Thomson-Houston Co., Chamberlain & Hookham, and the Westinghouse Electric Co. Estimated cost £480.

Poplar.—The Poplar Board of Guardians have accepted the tender of the Consolidated Telephone Construction & Manufacturing Company for maintenance, &c., of telephone, fire alarm and electric bell systems. The other tenderers were Messrs. Cox Walkers, W. Palmer, Stephens, Smith & Co., W. Graves, T. Warren, E. Clark, and the Private Wire and Telephone Installation Company.

OBITUARY.

We have to record with deep regret the death of Mr. Henry Charles Forde, of the firm of Clark, Forde & Taylor, which occurred suddenly at Epsom on the 21st inst. The deceased gentleman, after attending divine service, visited the house of a near relative, and was engaged in a general conversation, when he was overtaken by an instantaneous and painless collapse.

He was born in April, 1827, and had therefore nearly completed his 70th year, and was one of that early band of pioneers who devoted themselves, about the middle of the century, to the development of submarine telegraphy.

His education was received partly at home, partly at Brussels, and for three years at the no longer existing "College for Civil Engineers" at Putney.

From 1845 to 1852 he was variously engaged in Ireland, on railway, river, canal, drainage, and other engineering works, serving for some time on the staff of Mr. Charles Vignoles, afterwards President of the Institution of Civil Engineers. He was also employed on various public works during the years of the great famine in Ireland.

In 1852, at the invitation of Mr. Lionel Gisborne, he accompanied the latter on a visit to South America, to examine the Isthmus of Darien, in connection with the project of cutting a ship canal. This expedition, and also a subsequent one made to the same country in 1853, involved great hardships as well as risk from the hostility of the Indians, by whom, indeed, both explorers were on one occasion captured. For some unexplained reason, however, their lives were spared, and they met with no worse fate than expulsion from the country.

In 1854 Mr. Forde entered into partnership with Mr. Gisborne, and his long connection with submarine telegraphy dates from this year. The partners took up the question of a telegraph line to India and the far East, and by the aid of Lord Clarendon and Lord Stratford de Redcliffe, concessions for land lines across Egypt and for cables from the Dardanelles to Egypt and down the Red Sea were obtained.

On the strength of these concessions the Red Sea and India Telegraph Company was formed in 1857-58, the British Government supporting the enterprise by a 50 years' subsidy.

The cable was laid in 1860 and 1861 by Messrs. Newall, but it, unfortunately, proved a failure.

In 1859 the Government proposed to lay a submarine line between Falmouth and Gibraltar, and Messrs. Gisborne and Forde were appointed engineers. This cable, after one or two changes of destination, was eventually laid between Malta and Alexandria in 1861, and worked well.

In connection with this cable Mr. Forde and his partner, together with the late Sir William Siemens, carried out a series of exhaustive experiments on the breaking strains of the various materials used in the construction of submarine cables.

These experiments were made with the view of arriving at the best form of outer sheathing for cables, and Mr. Forde's evidence before the Joint Committee appointed by the Privy Council in 1861 to inquire into this matter was mainly directed to this point.

This, like all the work in which Mr. Forde took an active part, was carried out with conscientious thoroughness.

In the following year, 1862, Mr. Forde read a paper before the Institution of Civil Engineers on "The Laying of the Malta and Alexandria Telegraph."

But real activity in submarine enterprise may be said to date from 1869, in which year the "French Atlantic" line was laid. Between this period and the present time Mr. Forde and his partners supervised the manufacture and laying of cables amounting in total length to some 100,000 nautical miles, a mere list of which would fill a column of this review.

So far, we have sketched Mr. Forde's career from its professional side only; on its social side it is known to many of our readers, his genial manner and kindliness having won for him troops of friends, to whom the hospitable doors of his house at Wimbledon were always wide open.

Geniality of manner may be only skin deep, but in his case it was the outward and visible sign of a generosity that was not calculated; and few, indeed, there were who, appealing to him in trouble or difficulties, were sent empty away. By some of these his loss will be mourned in heart; by others, perhaps, in pocket only.

The writer of this notice has been closely associated with the deceased for more than 25 years, and he speaks of what he knows when he says that a man more honourable, more loyal, or more sincere, it would be hard to find. He is the spokesman of the Electrical Review in expressing our sincere sympathy and condolence with the bereaved family in their great loss.

The interment took place yesterday at Wimbledon, in the presence of a large number of relatives, friends, and sympathisers intimately connected with the deceased gentleman's profession.

NOTES.

The Lundell Motor.—As announced in our last issue, Messrs. J. H. Holmes and Co. have opened new offices at 17, Soho Square. On Thursday last week, by way of opening ceremony, they entertained a number of their business friends, the occasion being rendered additionally interesting by the presence of Mr. Lundell, the inventor of the electric motor bearing that name, who happened to be in London temporarily. Messrs. J. H. Holmes & Co. hold the English rights in this motor, for which it is claimed that for space occupied and current consumed it gives more power than any other. A new type is shortly to be introduced, of which we shall have some information to give later on.

Personal.—An Indian contemporary states that Mr. S. P. W. V. Luke, C.I.E., Deputy Director-General of Indian Telegraphs, retires from service in March.

Presentation.—Mr. W. Johnston, who has recently left the Sheffield district of the National Telephone Company, Limited, to take up the position of district manager at Wolverhampton, was on Wednesday last week the recipient of a handsome marble timepiece, which has been presented to him by the Sheffield staff as a token of their esteem.

Congratulations to Prof. Hughes.—The professors and students of the Polytechnic School of Engineering, Regent Street, presented their President for this year, Prof. D. E. Hughes, F.R.S., with an illuminated address, congratulating him upon the distinguished honour which, as stated last week, was conferred upon him on Tuesday, the 16th inst., when he received from the hands of H.R.H. the Prince of Wales, at Marlborough House, the Albert Medal, bestowed upon him by the Society of Arts.

Institution of Electrical Engineers. — The next students' meeting will be held at 28, Victoria Street, Westminster, on Wednesday, March 3rd, at 7.30, when a paper on "The Lighting of Country Houses" will be read by Mr. A. H. Graham (Student).

Lecture.—At Toynbee Hall, on 20th inst., Prof. Victor Horsley lectured to a crowded audience on "Electrical currents in the human body." The lecturer illustrated his remarks with a number of experiments.

The Institution of Junior Engineers.—On Saturday, March 6th, the conversazione will be held at the Westminster Palace Hotel. Reception at 7.30 p.m. by the President, Mr. A. R. Binnie, M.Inst.C.E., and Mrs. Binnie.

Fire.—We learn from the daily Press that a fire broke out on Tuesday morning at the Cox Thermo-Electric Company's laboratory at St. Albans, and resulted in the destruction of the buildings, with their contents. The most serious loss is said to be a personal one to Mr. Cox, whose machines and the whole of the records of his experimental work are destroyed. The general contents of the building are insured, but Mr. Cox had not insured his own collection of instruments.

The Royal Society.—The following papers were down for reading yesterday afternoon:—Prof. Dewar, F.R.S., and Prof. Fleming, F.R.S. "Note on the Dielectric Constant of Ice and Alcohol at very low Temperatures." Dr. E. T. Jones, "On the Relation between Magnetic Stress and Magnetic Deformation in Nickel."

The Northern Society of Electrical Engineers.—The fourth annual dinner of this Society was held last Friday, at the Grand Hotel, Manchester. Mr. Dorman presided. There was a goodly muster of members, and whether it be due to the superior climatic conditions of Manchester, or to some more obscure reasons, it is an unmistakable fact that the speeches were brighter and wittier than one usually hears at similar functions. Not that we should care to spoil the witty sayings by endeavouring to reproduce them. Mr. Raworth, in proposing the President and the Society, was at his best, and we all know what that means; he drew a picture of the troubles that have followed the birth of the voltmeter, the growth of electrical work in the Manchester district, and then he drew a veil over various other matters. Mr. Dorman gave us an interesting account of how he had been beguiled from the humdrum of a locomotive life to take up electrical work. He remembered only too well the early eighties which had been referred to, and the struggles of those times, and was also fully alive to the changes which had taken place since. He was pleased to find that the Society was increasing in numbers, and that they were getting members of the right sort—men who were well known, and men who held high positions in the trade. Mr. Edmunds humorously proposed "The Retiring President" (Mr. Fawcus), who briefly acknowledged the compliment. Mr. Z. de Ferranti gave "Our Guests," coupled with the names of Messrs. J. Nasmith and Allott. Mr. Nasmyth, in reply, said that electrical engineering was a new industry springing up, and had called for men to fill the gap at once. If the example of Germany, however, was a right one to follow, he was convinced that success would only attend their efforts in future in educating the young by first grounding them in a knowledge of steam plant. Let them be educated first as engineers, and then as electricians. He also counselled a closer association of kindred societies, which would be of enormous advantage to all.

NEW COMPANIES REGISTERED.

Motor Attachment Syndicate, Limited (51,265).—Registered February 15th with capital of £10,000, in £10 shares, to acquire and work a patent for an improved method of constructing, mounting, and arranging the underframe and driving appliance of electric and other road motor cars, and the means or apparatus for reducing vibration and oscillation, and to carry on the business of electricians, mechanical engineers, machinists, fitters, founders. The subscribers (with one share each) are:—T. E. Mithchell, 85, Gracechurch Street, E.C., clerk; H. Carmont, Helmsdale, Kingston-on-Thames, engineer; G. Burchall, 85, Gracechurch Street, E.C., solicitor; C. F. B. Burchall, 85, Gracechurch Street, E.C., solicitor; E. T. Fryer, Westwood, Sophia Road, Leyton, clerk; R. D. Leng, 7, Florence Road, New Cross, S.E., clerk; D. H. Dunman, 85, Gracechurch Street, E.C., agent. Registered without articles of association by Burchalls, 85, Gracechurch Street, E.C.

Thrupp, Holmes & McNaught, Limited (51,275).—Registered February 16th, with capital of £1,000 in £1 shares, to adopt an agreement, dated February 12th, with W. Day, and to carry on the business of motor manufacturers, cycle and carriage manufacturers and dealers, electricians, and engineers, machinists, fitters, founders, millwrights, smiths, wire drawers, &c. The subscribers

(with one share each) are:—H. C. Pedder, 16, Gt. Winchester Street, E.C., broker; R. E. Smith, 62, Willoughby Lane, Tottenham, clerk; H. Bartram, 19, Carlyle Mansions, Cheyne Walk, S.W., clerk; H. L. Smith, 52, Queen Victoria Street, E.C., clerk; C. Bassett, 17, Upper Charlton Street, Marylebone, clerk; T. O. Baxter, 25, Tichborne Street, W., clerk; E. W. Hailes, 23, Birchin Lane, E.C., gentleman. Registered without articles of association by Ashley & Co., 23, Birchin Lane, E.C.

Crystal Electric Lamp Company, Limited (51,335).—Registered February 19th with capital £28,000, in £5 shares, to adopt an agreement with said company and its liquidators, and to manufacture, sell, and deal in electric lamps and other apparatus, and to carry on the business of an electric light company. The subscribers (with one share each) are: H. J. Gibbs, Tentercroft, Streatham Park, merchant; R. R. Gibbs, Glenwood, Virginia Waters, Surrey, merchant; F. Naylor, 3, Woodland Road, New Southgate, solicitor; J. H. Smeed, 105, Bouverie Road, Stoke Newington, gentleman; S. Wiggins, Lyndhurst, Sutton, solicitor; H. E. Martin, 85, Halton Road, Canonbury, clerk; F. S. Wiggins, St. Stephen's Chambers, E.C., gentleman. The number of directors is not to be less than two, nor more than five; the first are the first three subscribers; qualification, £500; remuneration as the company may fix. Registered by R. Miller & Co., St. Stephen's Chambers, E.C.

Improved Incandescent Electric Lamp (Foreign Patents) Syndicate, Limited (51,347).—Registered February 20th, with capital of £900 in £1 shares, to adopt an agreement with S. P. Eastick, E. Sayer and F. Steinhoff, and to carry on the business of electricians, mechanical engineers, and suppliers of electricity. The subscribers (with one share each) are:—R. W. Muir, 20, Jewry Street, E.C., merchant; F. Steinhoff, Whitehall Road, Woodford, Wells, merchant; G. Steinhoff, Snakes Lane, Woodford Green, merchant; W. E. Leutchford, 123, Walwood Road, Leytonstone, clerk; J. Milmore, 6, Bolton Road, Harlesden, clerk; E. Sayer, Electric Light Station, Hampstead, electrical engineer; S. P. Eastick, 47, Ashford Road, Cricklewood, electrical engineer. The number of directors is not to be less than two nor more than five; the first are F. Steinhoff, S. P. Eastick, E. Sayer and R. W. Muir. Registered office, 20, Jewry Street, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Whitehouse & Thomas, Limited (48,533).—This company's statutory return was filed on January 28th, when 825 shares were taken up out of a capital of £3,000 in £1 shares; 818 are considered as paid, and £1 per share has been called on the rest. £3 has paid, and £4 is in arrears.

Callender's Cable and Construction Company, Limited (48,915).—This company's statutory return shows that the capital of £100,000 in £5 shares has been fully subscribed and paid up.

Amazon Telegraph Company, Limited (44,532).—This company's annual return was filed on January 21st, when the capital of £250,000 in £10 shares was taken up and paid for in full.

African Trans-Continental Telegraph Company, Limited (37,855).—This company's annual return was filed on December 8th, when the capital of £140,000 in £1 shares was fully subscribed. £1 per share has been called on 1,306, and 10s. per share on the others; £64,351 has been paid (including £85 paid in advance), and £6,387 is in arrears.

Davies Motor Company, Limited (49,068).—This company's registered office has been removed from 13, Gray's Inn Square, London, W.C., to 16, Red Lion Street, Clerkenwell, E.C. The company's statutory return has just been filed. The capital is £160,000, in £1 shares (of which 6,000 are preference). All the preference have been taken up, and 10s. per share called; £2,956 5s. has been paid, and £43 15s. is in arrears.

Dalziel's News, Limited (41,502).—This company's return was filed on January 21st. The capital is £150,000 in £1 shares (of which 60,000 are preference); 22,000 ordinary have been taken up and considered as paid, 2,007 preference shares have been taken up, and £1 per share called; £2,000 has been received, and £7 is unpaid.

CITY NOTES.

Westminster Electric Supply Corporation.

We have already given the chief points of this company's accounts, and there is very little to say beyond remarking upon the position of opulence which the company has attained. At the same time, when an enterprise reaches a stage of great prosperity, one likes to see a fair division of profits, and it is satisfactory to observe that a strong attempt is to be made to buy in the founders' shares. It is not until a concern reaches large profits that the founders' shares vex the soul of the ordinary shareholder, and it is to the real interests of the company to buy them out at once. We do not know whether they could have been bought out four or five years ago, but if it had been possible the shareholders would have ridden themselves of a burden which presses more heavily each year. Founders' shares always were troublesome things—except to the holders—and we are afraid that more than one electric lighting company will meet with considerable difficulty before they can hope to meet the extravagant desires of the holders of the founders'.

The analysis of the accounts is as follows:—

	1896.	1895.
Total capital expended	£478,870	£443,843
Number of units sold	3,503,054	2,830,396
Number of lamps connected	249,318	216,822
Revenue from sale of current	£81,214	£65,554
Net revenue	£40,431	£28,962
Average price obtained per unit	5·5d.	5·5d.

Cost of Production.	£	Per unit.	1895.
Coal	7,838	·54d.	·57d.
Oil, waste, water, and engine room stores	1,394	·10d.	·11d.
Salaries and wages at generating station	6,550	·45d.	·57d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	4,273	(Works' cost 1·38d.) ·29d.	·21d.
Rates and taxes	3,720	·25d.	·26d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges and insurance	8,231	·56d.	·68d.
Total	£32,006	2·19d.	2·40d.
Not included in above.			
To sinking fund	£1,000		
Depreciation account ..	12,100		
Amount for loss on coal stored	49		
Cost of supplying steam ..	1,044		
	14,193		
Total ...	£46,199		

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	81,214	0	0	5·5d.
Meter rents, &c.	3,718	0	0	—
Supply of steam	1,638	0	0	—
Transfer fees	62	0	0	—
Total	£86,632	0	0	5·5d.

Total cost per unit (exclusive of depreciation and renewal accounts), 2·17d.; works' cost, 1·36d.

Notting Hill Electric Lighting Company.

It is apparent that the Notting Hill Company is fast approaching to a prosperous condition. Two years ago the ordinary shareholders had to be content with an infinitesimal dividend of 2s. per £10 share, but last year it reached 2 per cent., and now they have arrived at a 4 per cent. dividend. The following table, taken from the directors' report, shows the steady progress that has been made during the past five years:—

1891	Lamps	6,056	Loss	£554	18	6
1892	"	9,438	Profit	112	6	1
1893	"	12,153	"	1,481	7	1
1894	"	15,669	"	2,101	17	8
1895	"	20,307	"	3,227	14	10
1896	"	25,716	"	4,736	9	8

The following are the principal points in the directors' report:—

"The expenditure on capital account at the date of the last balance-sheet stood at £83,998 14s. 1d. During the past year a further sum of £15,106 3s. 5d. has been expended, mainly accounted for by £11,415 15s. 8d. for mains, and £2,029 0s. 11d. for machinery. The total capital expenditure is therefore £99,104 17s. 6d. The balance of the preference shares, £11,380, was issued during the year at a premium of £2 per share. The amount of the premiums (£2,276) has been written off in reduction of the preliminary expenses, compensation and charges during construction, making a total amount written off these items of £2,829 12s. 7d.

"The provisional order to enable the company to supply current to the northern part of Kensington, obtained in 1895, but not confirmed owing to the dissolution of Parliament, received the Royal Assent on March 31st, 1896. This was sufficiently early in the year to enable considerable progress to be made with the necessary works, over £6,000 of the capital expenditure for the year having been incurred on this account. Further expenditure of about £2,000 has already been contracted for, and it is intended to expend an additional sum of £10,000 in the course of 1897. As the whole of the share capital is now issued, the directors propose to make use of their borrowing powers.

"The directors recommend the following allocation of the available profit:—

(1.)	To depreciation, renewals, and reserve fund	£1,000	0 0
(2.)	A dividend of 6 per cent., less income tax, on the ordinary preference shares for the year ending December 31st, 1896 (already paid)	1,172	10 3
(3.)	A dividend of 4 per cent., less income tax, on the ordinary shares	2,580	16 0

"The directors have decided to put aside each year out of the profits 1 per cent. on their capital expenditure to form a fund for depreciation, renewals, and reserve. The amount already standing to the credit of this fund is £2,340. In view of the fact that in the earlier years of the company no such provision could be made, the premiums obtained from the sale of the debentures will be added to this fund. The directors have decided to reduce their charge to 6d. per unit to customers willing to take current at a pressure of 200 volts.

"Mr. Geo. Schultz, engineer and manager, reports that the machinery, plant, and mains are in good condition, and that no accident of any kind has occurred during the year.

"It is with deep sorrow that the directors have to announce the death of their colleague, Mr. Sidney Waters, which took place on December 14th last, at the early age of 45. It was to Mr. Waters, who combined business training with a practical knowledge of electricity, that the company mainly owed its origin, and from the very first until a few days before his death he was untiring in his devotion to its interests."

The following table gives the cost per unit:—

	1896.	1895.
Total capital expended...	£99,105	£87,085
Number of units sold	230,787	182,327
Number of lamps connected	25,718	20,307
Revenue from sale of current	£7,366	£5,881
Net revenue	£4,736	£3,228
Average price obtained per unit ...	7·59d.	7·6d.

Cost of production.	£	Per unit.	1895.
Coal	683	·71d.	·79d.
Oil, waste, water and engine room stores	174	·18d.	·13d.
Salaries and wages at generating station	413	·43d.	·48d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	448 (Works' cost 1·76d.)	·47d.	1·03d.
Rates and taxes	—	—	·04d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	1,624	1·69d.	1·77d.
Total	£3,342	3·48d.	5·16d.
Not included in the above.			
Rates and taxes £263			
To connecting installations and sundry stores 210			
	473		
Total	£3,815		

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	7,366	0	0	7·59d.
Meter rents	397	0	0	—
Connecting installations	513	0	0	—
Rents renewable	266	0	0	—
Transfer fees	10	0	0	—
Total	£8,552	0	0	7·59d.

Total cost per unit (exclusive of depreciation and renewal accounts), 3·43d.; works' cost, 1·76d.

Hove Electric Lighting Company.

We have not dealt with a single report for 1896, whether it be company report or corporation, which does not show that distinct progress is being made in electricity supply in a commercial sense. The accounts of the Hove Company are as satisfactory as any we have seen, and it will be observed, from what follows, that it is gradually improving its position as a dividend earning concern. The principal points in the report are as follows:—

"The revenue from the sale of current has increased to £6,161 17s. 2d., while the costs of generation of electricity, distribution and management expenses amount to £3,404 8s. 8d., and after crediting the profit and loss account with meter rents and transfer fees, there remains a balance of net profit for the year of £3,114 5s. 6d. After adding to the above profit the balance brought forward from last year of £152 14s. 6d., and deducting £980 14s. 11d. for interest on loans and debentures, and income-tax, and £625 9s. 9d. for interim dividend paid in October last year, there remains a net balance to the credit of the revenue account of £1,660 15s. 4d. The directors propose to write off the sum of £150 from the preliminary expenses account, to place £300 to the reserve fund, to declare a dividend, payable on April 15th next, at the rate of 6 per cent. per annum for the half-year on the share capital (making with the interim dividend 5 per cent. for the year), and to carry the balance, £183 7s. 10d., forward.

"The number of lamps attached to the company's mains has now increased to the equivalent of 21,794 8-C.P. lamps, and the number of consumers to 313. The amount realised from premiums on shares and on debentures issued during the year has, after deducting brokers' commission on the same, been placed to the reserve fund, which will now show a credit balance of £1,563 17s. The sum of £260 6s. 11d., the balance of the amount set aside for repairs and maintenance, in accordance with the contract with the Hove Commissioners, after deducting amounts actually expended, has been placed to the depreciation and maintenance reserve account, bringing the total of this account up to £523 16s. 1d. The directors have pleasure in stating that the whole of the share capital has now been placed, the last shares having been issued at a premium of 10s. per share. Since the date of the last report the directors have paid off the whole of the £12,500 of 5 per cent. debentures, and have also paid off at par £200 of the 4½ per cent. debentures; in lieu thereof they have issued £14,600 of 4 per cent. debenture stock. As announced in last year's report, the directors have established the method of charging for current on what is known as the 'demand meter' system, being satisfied that this arrangement is a fair one, both for the consumers and the company. They have now, from January 1st this year, made a further reduction, by requiring only one hour's consumption per lamp at 8d. per unit, all current afterwards being charged at 4d. per unit.

"It is already apparent that the new rate of charging is giving satisfaction, as the returns for the current year to date show a considerable increase upon those of last year. In addition to the machinery added to the plant last year, the directors have made several extensions of the mains, which they have no doubt will add considerably to the number of consumers, as also to the company's revenue."

The following table gives the cost per unit:—

	1896.	1895.
Total capital expended	£62,022	£57,472
Number of units sold...	200,562	162,428
Number of lamps connected	21,794	18,403
Revenue from sale of current... ...	£6,162	£5,343
Net revenue	£3,114	£2,562
Average price obtained per unit ...	7·39d.	7·85d.

Cost of Production.	£	s.	d.	1896. Per unit.
Coal	655	0	0	·79d.
Oil, waste, water, and engine room stores	131	0	0	·16d.
Salaries and wages at generating station	731	0	0	·88d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	340	0	0 (Works' cost 2·22d.)	·41d.
Rent and taxes	223	0	0	·27d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	1,064	0	0	1·28d.
Depreciation of buildings and plant account	—			—
Renewal fund account	—			—
Total	£3,144	0	0	3·79d.
Not included in above.				
Depreciation account	260	0	0	
Total	£3,404	0	0	

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	6,162	0	0	7·39d.
Meter rents	353	0	0	—
Transfer fees	3	0	0	—
Total	£6,518	0	0	7·39d.

Total cost per unit (exclusive of depreciation and renewal accounts), 3·76d.; works' cost, 2·22d.

The House-to-House Electric Light Supply Company, Limited.

The directors state that the revenue account shows a credit balance of £9,031 18s. 1d., which, with the balance of £64 19s. 4d. brought forward, £58 12s. 7d. dividend on 300 £5 fully-paid ordinary shares in the Yorkshire House-to-House Company, Limited, and £28 11s. 4d. interest on deposit, makes a total of £9,184 1s. 4d. After deducting £2,312 1s. 9d. for interest on debenture stock paid and accrued and other interest, and £955 12s. 1d. for interim dividend paid on the

7 per cent. cumulative preference shares, the directors recommend that the sum remaining, viz., £5,916 7s. 6d, be dealt with as follows:—

To credit of depreciation account ...	£2,600	0	0
To payment of the remainder of dividend to December 31st, 1896, on the 7 per cent. cumulative preference shares ...	1,168	13	0
In reduction of preliminary expenses account	600	0	0
In reduction of the construction business development account	1,504	2	0
And that the balance of ... ... be carried forward to the next account	43	12	6
Total	£5,916	7	6

The amount of £839 received as premiums on the last issue of shares has been applied in further reduction of preliminary expenses account, thus reducing that item to £2,142 11s. 5d. The following table shows the progress of the company's electric lighting business since 1890:—

Year.	Equivalent of 35-watt (8-C.P.) lamps connected.	Increase in 35-watt (8-C.P.) lamps.	No. of houses connected.	Gross receipts.			Expenditure.			Net receipts.		
				£	s.	d.	£	s.	d.	£	s.	d.
1890	13,665	9,145	248	5,010	9	2	4,624	6	5	386	2	9
1891	19,388	5,723	373	8,328	3	11	6,077	14	10	2,250	9	1
1892	23,700	4,312	471	10,688	18	6	7,851	19	6	2,836	19	0
1893	28,429	4,729	599	12,063	10	10	7,832	6	8	4,231	4	2
1894	35,858	7,429	755	13,695	11	8	7,431	16	8	6,263	15	0
1895	44,162	8,304	932	15,394	16	11	8,554	0	10	6,840	16	1
1896	55,265	11,103	1,164	17,442	6	5	8,410	8	4	9,031	18	1

The increase in the number of lights connected during 1896 was equivalent to 11,103 8-candle-power (35-watt) lamps. Notwithstanding that from the end of the first quarter of 1896 the maximum price charged for current has been 6d. per Board of Trade unit in place of 8d., the revenue from electricity increased for the year by £1,836 10s. 7d., while the working expenses show a decrease of £143 12s. 6d. During the year additions and alterations to the plant and mains have been made, at a cost of £31,407 10s. 5d., and the expenditure for 1897 is estimated at £24,000. In order to provide for this outlay, a further issue of capital will shortly be made. The directors have again been advised that the accounts of the Leeds and London Electrical Engineering Company, Limited (to whom the business in connection with the construction business development account has been leased), do not admit of the distribution of any profit. In the event of the agreement with the Leeds and London Electrical Engineering Company, Limited, being determined during the ensuing year, it will be necessary to reinstate such proportion of the above asset as may be deemed irrecoverable. During the year 1896 a further 1,678 ordinary and 1,678 7 per cent. preference shares were issued.

Mr. Henry Ramie Beeton (chairman) presided over the ninth ordinary general meeting of the above company, held on Thursday afternoon at Winchester House, and in moving the adoption of the report, said:—The report and accounts, which are in the hands of shareholders, show continuous growth of business with attendant increase of profit, and, taken in conjunction with those of other companies, they testify not only to the growing popularity of electricity as an illuminant, but also to the establishment of electric lighting as a profitable field for the investment of capital. Regarding the revenue, we find that whereas at the end of 1895 we were supplying 932 customers with 476,714 units, at the end of 1896 we were supplying 1,164 customers with 617,413 units, and that after extending our business every year for seven years, the new business last year exceeded that in any previous year of our history. This increase in our sales is partly due to a reduction in our price for electricity, which has itself been rendered possible by a reduction in our cost of production, consequent in great measure upon the growth of our business. For nine months out of the twelve under review, the charge to our customers has been on the basis of 6d. instead of 8d. per Board of Trade unit, and yet, notwithstanding this, our revenue has increased from £15,394 to £17,442, or by £2,048. It is matter for congratulation that, notwithstanding the comparatively uneconomical load with which we have to contend in an essentially residential district such as ours, we have been able to keep step with our more fortunately situated neighbours, and to reduce the price of electricity to our customers without injury to our shareholders. Regarding expenditure, it is a still more satisfactory feature of our progress to find that we have earned our additional revenue not only at a relative, but at an actual reduction in cost. Whereas in 1895 we supplied 476,714 units, and in 1896 we supplied 617,413 units, exclusive of the current used in the works, the larger quantity actually cost £143 less than the smaller, and this notwithstanding that owing to the quinquennial revision of the assessment of property in the Metropolis our rates have more than doubled, having increased from £224 in 1895 to £500 last year. The expenses of generation and distribution, comprised under the headings A and B in the revenue account, amount to a total for the past year of £5,735 as against £6,370 for the previous year, representing a reduction in works' cost from 3·2d. per unit to 2·138d. per unit, or a reduction of slightly more than 1d. per unit. This is partly due to more economical generation, whereby we have saved more than 10 per cent. in coal and about 35 per cent. in water, and partly to more efficient distribution, whereby we have saved nearly 40 per cent. of the loss of electricity on our mains and transformers. This saving in distribution is an important advance in the conduct of our business, and is due to the extension of the system of distribution known as the "low tension network" system, whereby instead of the current being transformed from 2,000 to 100 volts on the customers' premises, the process is now mostly effected at sub-stations and other centres. By this arrangement we not only save a considerable quantity of current, but also some capital expenditure, and inasmuch as we have still some hundreds of old customers to whom the new arrangement remains to be applied, and as the year under review has not derived the full benefit of the change, it is probable that there will be a further improvement during 1897 in this particular. These economies, due to improved methods of working, and to extension of business, whereby we are able to earn more money with a very small increase in working expenses, are what shareholders may confidently look to for the reward of their patience. Had it not been for the necessity of writing down preliminary expenses and construction asset accounts, a sum of over £2,000 would have been available for dividend, which would have been equivalent to 4 per cent. on the ordinary shares. Without, of course, pledging ourselves, we hope we shall be able during the current year not only to further reduce the balance of the preliminary expenses, and to extinguish such portion of the construction asset as may be deemed irrecoverable, but also to pay a small dividend on the ordinary shares.

Mr. R. A. Germaine seconded the motion, and it was carried.

City of London Electric Lighting Company, Limited.

The ordinary general meeting of this company was held at Winchester House on Wednesday, Sir David Salomons presiding.

The Chairman, in his opening remarks, said he should have liked to have seen every shareholder present, so that they might put such questions as would show by the replies that everything was being done to the best advantage and in good faith. The report showed that the advance of the company had been exceedingly rapid, notwithstanding the technical papers, who were supposed to know, but did not. Notwithstanding the large number of lamps connected, there was still room for large expansion in their business. Applications for lamps came in undiminished numbers, but it is recognised that this would not last for ever. A point they had always kept in sight is that capital raised in the future should be expended as far as possible to earn a profit, and the capital for which they would be asked would only be raised as the necessities of the undertaking required. It was hoped that the capital which was expended in the future would not diminish the return to the ordinary shareholders, or endanger any class of holders in the company, but would strengthen matters very considerably. The directors thought that almost every pound judiciously spent would improve the commercial value of the company, the benefit of which would be felt by the debenture holders, the preference shareholder, as well as the ordinary. It might appear that the preference shareholder had not been as well cared for as the other classes; but it should be remembered that any policy pursued for the benefit of the ordinary shareholder must give an improved value to the holdings of the preference and debenture; moreover, the ordinary shareholder had borne the brunt of the past, and after due consideration, the board thought it right to give the issue in the manner suggested. The applications for lamps was equivalent to 268,500, and the number actually connected was 256,650. There was an impression that during a fog there would be a tremendous load put on the machinery of such a nature that it would require heroic measures to get over the difficulty. Probably there was good reason for this when there were very few lamps on the installation, because all those that first came on required the whole of their lamps or none, but now that normal conditions had been reached, there was an average struck; the whole of the City was not necessarily in darkness at the same time, and some consumers had more lamps than they actually used. They had now an evening load, which was equal to the load during the greatest fog, and it was a matter on which they might congratulate themselves that in the greatest fog there was no greater strain upon their station than upon any ordinary evening. There was, however, one disadvantage, and that was, when a fog threatened, that a number of additional boilers should be kept in readiness; but that ought not to be looked upon in that light, for it was insurance money, in the way of extra coal, to avoid the possibility of breakdown by the large number of lamps coming on. Some of the alternators had been remodelled with excellent results, the output having been greatly increased, and they were being kept at work now without the least fear of breakdown; that must be interpreted that without occupying any more ground, they were obtaining a larger output than they had before. They had ordered some more very large machines to meet the demands for next winter, and for reserve. Although the company had made experiments in the lesser streets for the City authorities, no order had yet been given to light those streets. They must all congratulate their engineer, Mr. Frank Bailey, upon succeeding in bringing Thames water into their works. A large sum of money had been spent on condensing pipes; but until recently, on account of the accumulation of straw and rubbish in the river, the strainers became completely choked after a very few minutes. Mr. Bailey had arranged a most ingenious device—a revolving drum of a special nature—and it effectually cured the disease. The engines were now condensing, and the system when completed would save a considerable sum in coal. Although his (the chairman's) name was associated with that of Mr. Bailey in the patent, it was entirely due to Mr. Bailey, and it was satisfactory to know that they had the

right to use the apparatus free of royalty. He wished again to refer to a point which was very often overlooked, namely, the large amount of capital which remained idle in the shape of conduits in the city streets, since it was determined, if possible, not to reopen those streets a second time. The advantage to be gained by such a proceeding was obvious. The engineer was able to give current to almost any house in the city the moment it was applied for, which otherwise would be impossible, and it was in consequence of that policy having been followed from the very first that the progress of the company had been so rapid. He next referred to one or two of the general outgoings. Some of them were not within the control of the board. For instance, there was the Parliamentary depreciation fund, and there was an increased payment for rates. In the matter of insurance, electric lighting stations had been unfairly treated by their all being placed on one basis, without any consideration as to the circumstances which ought to apply to each. Some were entirely or practically fireproof, while others were in a very bad condition, and yet there was a uniform tariff of 10s. 6d. per cent. charged. After a great many efforts this company had got the tariff reduced to an average rate of 7s. per cent. This, however, they considered very high, and negotiations were going on in the hope of getting a further reduction. Unless insurance offices came to their senses they would lose this class of business, and it would pass into a new channel. A short time after the formation of the company the board decided to give up Wool Quay—which they were practically compelled to take over in taking the various orders—it being unsuitable as a generating station. Negotiations had been going on with their landlords, the Fishmongers' Company, and other bodies with a view to turning this spot to good account. The annual rental was £4,000—a considerable charge on the undertaking. He was glad to say they had come to an arrangement with a shipping firm which would relieve them of that tenancy, but the benefit to be derived therefrom would not be felt in the present year. Turning to the accounts, it was satisfactory to observe that the depreciation and reserve funds were represented by investments and not mere book interest. In conclusion, the chairman bore testimony to the valuable services of his colleagues and the officers of the company.

Mr. Geo. Herring seconded the resolution.

The report was adopted, and the preference dividend declared; a 7 per cent. dividend on the ordinary shares was declared, and a resolution was subsequently passed increasing the capital of the company by the sum of £400,000, divided into 40,000 ordinary shares of £10 each.

A special vote of thanks was given to the staff, coupled with the names of Mr. Cecil Bull, the secretary, and Mr. Frank Bailey, the engineer.

The Douglas Southern Electric Tramways Company, Limited.

The annual general meeting of this company was held last week in Manchester, Mr. G. W. Lowcock presiding. The statement of the accounts covered the period from the incorporation of the company in October, 1895, to October 31st, 1896, showing that during that period there had been, on profit and loss account, an expenditure of £904, and an income of £1,078, the difference being a balance of profit on the seven weeks' working of the company's tramways during last season.

The Chairman, in moving the adoption of the accounts and the auditor's report, said it was intended in the first place to lay only 2½ miles of tramways to Little Ness, but the directors afterwards thought it best to lay the whole length to Port Soderick at once. From August 7th to September 5th they carried no fewer than 53,536 passengers. They were compelled to carry them only a short distance, and they charged 3d. each way as fare. They were under agreement to pay 1d. toll per passenger to the Marine Drive, Limited, but that company had acted considerately under the special circumstances of the short season, and had taken only ½d. per head. From September 5th to the 24th they carried 16,594 passengers at their increased rate of 1s. for the return journey. If they could depend on the figures, they said, to his mind, very pleasant things, and the company ought to be able next year to produce a balance-sheet which would give the shareholders every satisfaction.

Mr. W. Devenport seconded the motion, which was supported by Mr. T. J. Hutchinson (Bury), and carried.

The India-Rubber, Gutta-Percha and Telegraph Works, Limited.

The ordinary general meeting of this company was held at Cannon Street Hotel yesterday, the Hon. Henry Marsham presiding. In his opening remarks the Chairman regretted the absence of Mr. Gray through illness. He had been ill from the commencement of the present year, but they hoped he would shortly be able to go abroad. He would call their attention to the debtor side of the accounts, where the item mortgage debentures stood at £300,000, against £100,000 last year. This arose from the operations of March last, when the 4½ per cent. debentures were called in, and £300,000 debentures raised at 4 per cent. Under the item debts and loans, which stood at nearly £36,000, there was no loan element; it consisted of their current trade debts. Last year there was £150,000 under this head; but they were then just finishing the Cuba cable, and had to borrow till they could use the money for the cable. The item of profit and loss was £2,000 better than the previous year. This was mostly due to the good steady general business which had been obtained in the face of ever increasing competition, and notwithstanding the difficulty of obtaining new cable contracts during the past year. They had an order for the manufacture of a cable for the Japanese Government, which was carried out to the satisfaction of that Government. They had also executed the manufacture and laying of the Borkum cable, to the satisfaction of the Anglo-German Postal Departments. The other side showed a great item of the property, notwithstanding £16,000 depreciation written off, had increased by £4,000, leaving £20,000 well spent on buildings and new machinery. They must endeavour to keep level with the newest development of machinery, and adopt everything they found useful and tending to economy in labour. This sum also included money laid out in dining hall and reading rooms for the workpeople, which would be shortly completed. They had some time ago written off the depreciation of steamships to a considerable amount, and next year they would probably consider the question again. During the year the *Silvertown* had laid the Borkum cable, the *Dacia* had been hired for a short time by the Spanish Government, and the *Buccaneer* had been hired by the Western and Brazilian Telegraph Company. After referring to the death of Mr. Tyler, the late secretary, in feeling terms, the chairman moved the adoption of the report, which was carried.

The retiring directors and auditors were then re-elected, and the meeting terminated.

Isle of Man Tramways and Electric Power Company, Limited.

The report of the directors of the Isle of Man Tramways and Electric Power Company, Limited, for the past year shows an available profit of £15,847. Interim dividends on the preference and ordinary shares of 6 and 7½ per cent. had been paid, and further distributions of 6 per cent. on the preference and of 8½ on the ordinary were now declared, adding £2,000 to reserve and carrying forward £2,047. The traffic over the several systems showed satisfactory results. The cable tramway had exceeded the most sanguine expectations, and the Snaefell Mountain Railway had proved most beneficial. There was an enormous traffic on the Douglas and Laxey sections. Quotations for the company's shares had been obtained on the Manchester and Liverpool Stock Exchanges.

Chelsea Electricity Supply Company, Limited.

The directors' report states that the increase of the nominal share capital of the company from £100,500 to £200,500, was authorised by the shareholders on April 30th, 1896, and in May an issue of 12,000 ordinary shares of £5 each was made, and was fully subscribed. The final instalment on these shares, due on January 1st, 1897, has now been paid, and a Stock Exchange quotation for the new issue is being applied for. The balance of premiums on the above, after deducting the expenses of issue, amounts to £18,184 16s. 5d., and, following the course adopted in the accounts of the previous year, a portion of this has been applied to the extinction of the legal and other extraordinary expenses incurred during the year in connection with Cadogan Gardens station. The balance remaining, £14,818 7s. 5d., has been placed to the reserve fund, making the total of that fund £15,865 14s. This and some further capital not required in 1896, has been invested in Government and colonial stocks. The net revenue for the year, after payment of interest on debenture stock (£2,700), is £9,164 7s. 4d., and the directors recommend that it shall be applied as under:—

	£	s.	d.
Renewals and depreciation fund	2,000	0	0
Interim dividend of 6 per cent. per annum on the preference shares for the half-year to June 30th, 1896 (paid July 1st, 1896)	900	0	0
Dividend of 6 per cent. per annum on the preference shares for the half-year, to December 31st, 1896...	900	0	0
2½ per cent. per annum on the instalments paid up on the new issue of ordinary shares (as stipulated in the prospectus)	337	10	0
5 per cent. for the year 1896 on the fully paid ordinary shares (old issues)	3,500	0	0
Balance to be carried to next account	1,526	17	4
	£9,164	7	4

The number of lamps connected on December 31st, 1896, was 80,460, an addition of 23,106 during the year, or three times the average increase of the last three years. A corresponding increase will be seen in the capital expenditure; and in view of this large increase in demand, and the future development of the business, the leasehold interests on a portion of the company's freehold have been acquired, and a new generating station, capable of considerable extension, has been erected and equipped.

Telegraph Construction and Maintenance Company, Limited.

The report of the directors of the Telegraph Construction and Maintenance Company, Limited, with accounts to December 31st, to be submitted to the general meeting to be held at 38, Old Broad Street, E.C., on 2nd prox., states that the accounts for the year show a net profit of £88,300, after charging the interest on the debentures. To this sum must be added £18,870 brought forward from last year, making a total of £107,170. From this amount is deducted the interim dividend of 5 per cent., paid July 21st, 1896, amounting to £22,410, leaving £84,760 to be dealt with. Of this sum the directors propose to distribute a dividend of £1 4s. per share, absorbing

£44,820, being at the rate of 10 per cent., and making, with the amount already paid, a total dividend for the year of £1 16s. per share, or 15 per cent., free of income-tax, leaving £39,940 to be carried forward. The business of the company has been satisfactory, and shows some improvement over last year. Both the company's factories have been fairly active, and the steamships have been employed in laying or repairing submarine cables under contracts, and also on charter. The factories and machinery, which are constantly undergoing improvement, are at the present time in a higher state of efficiency than they have ever been before. The steamships have been thoroughly overhauled, and are now in good and thorough repair.

The Charing Cross and Strand Electricity Supply Corporation.

On Wednesday the annual meeting was held at the offices, 15, Maiden Lane, Covent Garden, Mr. G. H. Brougham Glasier presiding. Mr. E. Wilmot Sealy (the secretary) read the notice convening the meeting.

The Chairman, in moving the adoption of the report and accounts for the year ended December 31st, 1896, said the shareholders were probably as pleased as the board was that the accounts were so satisfactory. He felt sure they would join with the directors in regretting the loss of their old colleague, Mr. Agostino Gatti, and they probably approved of the appointment of his eldest son (Mr. J. M. Gatti) to a seat on the board. Regarding their Strand provisional order, the results would speak for themselves and show the advantage to the company of obtaining the increased area in which to carry on their business. Since the order had been obtained they had proceeded with the construction of the new station which they called the "central" station. It was not exactly situated in the district, but very close, the River Thames being the only dividing boundary. The station had been very nicely fitted up under the superintendence of the chief engineer, and at the close of the meeting an omnibus would be in waiting for those who wished to inspect the new buildings. The number of miles (41) of mains which had been laid down in the new district had probably surprised them. The stations had been well maintained, and the engineer's report was eminently satisfactory. Regarding the sale of current, the prosperity of the company had been continued through the past year to even a greater extent than the preceding years. The directors were now going to issue a further sum of £50,000 4½ per cent. preference shares of £5 each. The prospectus would be opened and closed on March 9th. The shares would be issued as far as possible *pro rata* at £6 per share. This was the remainder of the preference capital, and it was wanted for further work in developing the new district. The net earnings amounted to £15,288 odd. £622 odd—the balance of the law costs, suspense account—had been written off. £3,579 had been paid in respect of the interest on the debentures and temporary loan up to December 31st last. £3,625 was distributed in payment of the interim dividend at 5 per cent. for the half-year ended June, 1896, leaving a sum of £7,461, to which was added a balance of £1,397 carried forward, giving a total of £8,858. This would provide for 4½ per cent. on the preference shares, and 7 per cent, for the half-year on the ordinary, and allow them to carry forward £2,986.

The motion was seconded by Mr. Robertson (a shareholder) who referred specially to the sum of £700 directors' fees which, he stated, included arrears due to them for past years. He thought that they would very readily vote the amount. The shareholders might congratulate themselves upon having no founders' shareholders.

The resolution was carried unanimously, as also were the resolutions declaring the dividends, and electing the directors and auditors.

The Chairman next gave some detailed particulars regarding the accounts, the analysis having been worked out by one of the company's officials. He said the figures were not very pleasant reading, but shareholders would appreciate their satisfactory nature. In 1895, the company's fourth year, the capital expended was £219,000; at the present time it is £309,603. In 1895 the revenue from supply was £27,859, and last year it was £38,105. The revenue from meter rents and other sources was £480 in 1895, and £699 in 1896. The total revenue in 1895 was £28,339, and in 1896, £38,804. The total costs in 1895 were £12,752, and in 1896, £18,662. The gross profit before setting aside for interest, depreciation, and reserve, in 1895, was £15,587, and in 1896, £20,142. The percentage of costs to revenue in 1895 was 44 per cent., and in 1896, 48 per cent. The percentage of gross profit to capital—the outlay being averaged during each year—was 7·23 per cent. in 1895, and 7·62 per cent. in 1896. Interest on loan capital, less credits, was in 1895, £3,262, and in 1896, £3,579. In 1895 they set aside for depreciation and reserve, £4,000, and in 1896, £5,477. The percentage to depreciation as regards capital was, in 1895, 1·5 per cent., and in 1896, 2·07 per cent. The surplus for the year 1895 was £8,325, and for 1896, £11,086. The number of 8 C.P. lamps on December 31st (arcs, incandescents, and motors being reduced to 8 C.P.) was, in 1895, 51,302, and in 1896, 73,464. The number of units sold was, 1895, 1,383,813; 1896, 1,944,402. Units sold per lamp—the connections during the year being averaged—29·8 in 1895, and 32·4 in 1896. The revenue per lamp was in 1895, 12s. 2d., and in 1896, 12s. 8d. The price charged for private lighting was the same in each year, 6d. per unit, and for power and heating it was 4d. in 1896, against 5d. in 1895. The average price obtained in 1895 was 4·85d., and in 1896, 4·70d. The directors hoped that the year 1897 might turn out as successful, and perhaps more so, than 1896.

In reply to a question put by Mr. Robertson, as to how it was that they got so very much lower a price for their supply than any other London company, the Chairman said they had two companies competing against them in part of their district, and then there were customers who wanted a very large number of lamps; one wanted 8,000 lamps, others 4,000, 2,500, 2,000, 1,000, 800, and so on, and for such customers there were sometimes special terms necessary.

A vote of thanks to the chairman closed the meeting.

Westminster Electric Supply Corporation, Limited.

The ordinary general meeting of the shareholders of the above company was held on Wednesday, at the offices, Eccleston Place, Belgravia, Lord Suffield, K.C.B., presiding.

Mr. Frank Iago (the secretary) having read the advertisement convening the meeting, the directors' report and accounts were taken as read.

The Chairman, in moving the adoption of the report, said:—Gentlemen: I am very pleased once more to be able to congratulate you on the satisfactory progress made by the company during the past year. As you will see from the report, the number of lamps added during the year was 38,336—that is slightly above the average for the preceding four years, which is 37,000 lamps. Taking 7s. as the amount of annual revenue from each lamp installed—which is less than the actual figure—you will see that we are adding, on an average, about £13,000 each year to our income from lighting alone. This rate of progress is being fairly well maintained at the present time, and although, of course, we cannot expect to keep up this rapid growth indefinitely, there is still plenty of room in our district for a large extension of lighting, for over a large portion of our area the supply is as yet practically untouched; and we may, moreover, anticipate in the near future that our business will still further increase in consequence of the introduction of electrically-propelled vehicles—our system of supply being specially suited for charging accumulators. Of course, the increased business cannot be met without increased capital expenditure, and it has been found necessary to extend the generating stations to meet the heavy work of the coming autumn and winter months. The extension of the Millbank Street station is already proceeding. We have now obtained possession of additional land at Davies Street, and the extension there and at this station—Eccleston Place—will be commenced as soon as possible. The revenue account shows the large increase of nearly £17,500, or nearly 25 per cent. over the previous year, whilst the working expenses have only increased by £3,265, or 11 per cent., which you will no doubt regard as very satisfactory. The accounts, however, speak for themselves, for after making ample provision for depreciation and sinking fund, both of which, I am sure, the proprietors will agree with us are very necessary, and writing off the balance of the preliminary expenses—which expenses have weighed on us for a considerable time—we are able to recommend the payment of a dividend of 9 per cent. for the year, that is to say, 12 per cent. for this half-year, which makes 9 per cent. for the 12 months. I don't know that I need say anything in respect of that. I have, however, heard it rumoured that there was an expectation of a still further increase of dividend, that is to say, I understood that it was expected that we should pay at least 10 per cent. The proprietors will see from the report before them how the profit has been appropriated, and I hope they will agree with the directors that such a course was preferable to paying a further increased dividend this year. You will see the usual diagrams on the wall, and the engineer-in-chief can give any explanation, or answer any questions, which you may wish to ask on that subject. You will doubtless all have noticed the proposals of the board with reference to redemption of the founders' shares, but that is a matter which will have to be dealt with at an extraordinary meeting, which will be held as soon as the ordinary business has been completed. I will therefore now formally move: "That the report of the directors for the past year be received and adopted."

Mr. E. Boulnois, M.P., seconded the motion, which was carried unanimously.

The Chairman then moved: "That a dividend be declared for the past half-year at the rate of 12 per cent. per annum, less income-tax, payable on March 1st, making 9 per cent. for the year."

Mr. Browne Martin, in seconding the resolution, which was agreed to, said he was sure that all the shareholders must agree that the company had been conducted in a most satisfactory manner, and when motor cars became more used he believed they would be able to pay a still larger dividend.

Mr. D. Hatton proposed the re-election of Mr. W. Hayes Fisher, M.P., as a director of the company.

Mr. Boulnois seconded the resolution, which was carried, and on the motion of Mr. F. A. White, seconded by Mr. Stratton, Mr. R. W. Wallace, Q.C., the other retiring director, was re-elected.

Redeeming the Founders' Shares.

An extraordinary meeting was then held to consider the question of redeeming the founders' shares.

The Chairman said that as Mr. Hayes Fisher was almost the largest holder of ordinary shares in the company, and had given great attention to the matter of buying out the founders' shares, he would ask him to propose the resolution. From Mr. Fisher's position as an ordinary shareholder he might be trusted to take quite an impartial view regarding the proposal to purchase the founders' shares.

Mr. Hayes Fisher said that, in response to the request of the Chairman, he begged to move the following resolution:—"That, in order to redeem the founders' shares, the directors be empowered to offer to the holders of the founders' shares 80 ordinary shares of £5 each fully paid (out of the unissued capital of 12,000 shares) for each founders' share of £5." He said that, as had been stated, he was one of the largest holders of ordinary shares, and at one time he was the largest holder, and he put that forward very strongly, because the founders' shares were also held by himself and his co-directors,

he, however, only possessing one founders' share. He was the originator of this scheme of redemption, and they would clearly understand that, being such a large holder of ordinary shares, he would not be likely to advocate anything which would in any way depreciate the value of the ordinary shares which it was proposed they should give in exchange for the founders. He did not believe there was a man who had any dealings in the City who did not agree that, as a matter of policy, it was always wise to, if possible, extinguish founders' shares. There were many reasons for that, the most common being the fact that as long as there were founders' shares standing in rivalry with ordinary shares, there was always some uncertainty attached to the property, and as to the price that could be obtained for it. The whole question then became one of price. He wished to say that this was the first opportunity the directors had had of considering this question, because this was the first year that the founders' shares were entitled to a dividend of any considerable amount. There was £2,552 1s. 8d. due to the founders' shares, which would give them—there being 100 shares—£25 10s. each for the past year. They were also in a position to consider the matter this year, because for the first time they proposed to issue new capital, which they did not absolutely require, and therefore they would have the money in their pockets to buy out the founders. Two of their directors were the largest holders of founders' shares—Mr. Browne Martin and Mr. Wallace, while he (Mr. Fisher) and the other members of the board held one share each. It was plain, therefore, that the offer could not come from either of these two gentlemen, and he might tell the shareholders that they were unwilling sellers at the price which the directors offered. He would ask the shareholders to look at the proposal from a practical point of view, if they thought the price offered a big one. It never mattered in buying anything what the person got from whom they were purchasing; the whole question they had to ask themselves was whether it was good business for those who sold, and he could frankly tell them that if they knew the history of the company, which was now a splendid paying concern, they would not grudge Mr. Martin or Mr. Wallace one penny piece of the profits which they were going to make as a reward of their perspicuity in starting the company. Undoubtedly they not only risked a great deal of money, but also they risked their commercial reputation. They were among the first pioneers in London of this great development of electricity, which had subjugated the forces of nature to the use of man, and gentlemen who had the courage and enterprise to do such things deserved to make a handsome profit if they succeeded. They valued their founders' shares very much, and they would not part with them if it were not that they felt, as directors, that they wanted to bring themselves into line with their colleagues on all matters affecting the interests of the company. They did not want any friction to arise in the future as to the division of the profits—they wanted to be in a position to take the same view of the interests of the ordinary shareholders as their colleagues, and it was that alone which had induced them to accept the price offered, and to get the co-holders of founders' shares to agree to the proposal. As to whether the transaction was a good one for the ordinary shareholders, that could best be proved by considering a few figures. If they carried the resolution, they were going to give for the 100 founders' shares which they bought 8,000 ordinary shares of £5 each, which would amount to £40,000, on which they would always have to pay the current rate of dividend, whatever that was. Supposing they paid 10 per cent. next year, they would have to pay the holders of the founders' shares £4,000. For that investment of £40,000, the ordinary shareholders bought one-fourth of the net profits after the ordinary shareholders had been paid 7 per cent. Let them look forward to a 10 per cent. dividend next year, as they might reasonably hope. They would then be giving £4,000 to the holders of these 8,000 shares, and they would be obtaining almost precisely the same sum for themselves as ordinary shareholders. Should they pay 11 per cent., they would be paying at the rate of £4,400 a year on the new shares, and they would be receiving £5,250. If they paid 12 per cent., as he had every confidence that before long they would, they would be paying to the holders of these exchanged shares £4,800 a year, and they would be obtaining for themselves, as ordinary shareholders, £6,000. Undoubtedly, therefore, it was a good bargain for the ordinary shareholders, for if they paid 12 per cent., as he felt confident they would, they would be making a handsome profit of £2,000 each year on the transaction, which profit might be set aside to the reserve fund. Of course it was a speculative transaction, but there was not much to fear. Supposing there were no profits beyond 7 per cent., then the ordinary shareholders would not obtain anything from the bargain; if they paid 8 per cent. they would have made a bad bargain; if 9 per cent. they would not have made a very bad bargain; if 10 per cent. they would have made a good bargain; if they paid 11 per cent. they would have made an excellent bargain; and supposing they made 12 per cent. they would have made a splendid bargain. The whole question was—what was the future of the company going to be? and he, for his part, had the greatest confidence on that point. Not only was their area not yet filled up—not only was the number of their lamps continually increasing, but they also might expect large developments in the motor car industry, and if they could obtain a day load, the founders' shares would be worth double what the holders were now willing to sell them at. Possibly there might come a reduction in the price of electricity, but even if it came down to as low as 4d., Mr. Browne Martin was of opinion, and he (Mr. Fisher) agreed, that the company would be able to pay 11 or 12 per cent. He felt sure that if the resolution were adopted it would turn out a profitable investment for the company, and so far from depreciating the property of the shareholders, he believed it would increase it.

Mr. Boulnois, in seconding the resolution, said he thought it ought to be stated that Mr. Martin and Mr. Wallace—the largest holders of the founders' shares—took no part in the discussions at the board meetings at which the arrangement was come to, nor were they even present. He hoped the shareholders would carry the resolution, because otherwise, in the near future, there was sure to be a considerable amount of irritation caused between the holders of founders' and ordinary shares, at the very extraordinary dividend to which the former would be entitled. To-day the founders' shares were paying 250 per cent.; next year it might be more, and probably it would soon be doubled. It would therefore be wise on the part of the shareholders if they accepted the present opportunity to extinguish the shares altogether, for the chance might never occur again. He believed they were making a grand bargain for the shareholders. After a short discussion the resolution was unanimously carried.

Mr. White, in proposing a vote of thanks to the chairman and directors, said he thought they were greatly indebted to those gentlemen for the amicable arrangements they had been able to arrive at with reference to the redemption of the founders' shares. It was evident that there had been a "give and take" spirit displayed in the transaction, which reflected the greatest credit on all concerned.

Mr. Harold Young seconded the motion, which was carried, and the chairman having briefly acknowledged the same, the proceedings terminated.

The Scarborough Electric Supply Company, Limited.

The directors report that the company continues to make satisfactory progress. During the past year 63 new customers, and the equivalent of 4,939 8-C.P. additional lamps, have been connected to the company's mains, making a total of 298 customers and 17,727 8 C.P. lamps connected at the present time. To meet these requirements 1,175 yards of additional mains have been laid, while the capacity in cables and transformers has also been correspondingly increased. During the past year electric energy to the amount of 179,360 Board of Trade units has been supplied to customers at a revenue, including meter rent, of £4,383 5s. 11d., as against 141,101 units and £3,466 10s. 5d. revenue for 1895. The company has made a profit on the year's working of £1,617 8s. 8d., as against £937 9s. 8½d. in 1895, adding the balance of £304 8s. 2d. carried from the previous year, there is, after paying income tax, 1895-6, £13 18s. 8d., and bank interest £31 18s., and writing off the sum of £275 6s. 8d. from the preliminary expenses account, a sum of £1,600 13s. 6d. available for distribution. The directors recommend that this should be applied in paying a dividend of 4½ per cent., which will absorb £1,456 17s. 6d., leaving a balance of £143 16s. to be carried forward. It will be observed that no direct appropriation has yet been made on account of depreciation, but that £275 6s. 8d. of the preliminary expenses account is proposed to be written off. The directors consider that this covers a sufficient depreciation to date, seeing that all the machinery and plant is new and is maintained in good working order. Mr. Geo. Alderson-Smith, Mr. Geo. L. Beeforth, and the Hon. C. A. Parsons retire by rotation, but are eligible and offer themselves for re-election as directors. The auditor, Mr. C. E. Bradley, C.A., also offers himself for re-election.

Eastern Extension, Australasia, and China Telegraph Company, Limited.—At an extraordinary general meeting held on Thursday last week at the offices, Winchester House, the Marquis of Tweeddale presiding, the special resolution which was passed at the extraordinary general meeting on the 3rd inst. was confirmed on the motion of the chairman, seconded by Mr. F. A. Bevan. The resolution was for varying the regulations of the company by adding a clause to the articles of association as follows:—"86a. Continuing directors may act notwithstanding any vacancy in their body, and may fill up any casual vacancy in their number." By the recent death of Mr. G. G. Nicol, the number of directors is one below the *minimum* of six fixed by the original articles.

Stock Exchange Notices.—The Committee has appointed Wednesday, March 3rd, a special settling day in the London Electric Omnibus Company, Limited; 50,007 shares, Nos. 80,001 to 130,007.

Applications have been made to the Stock Exchange Committee to appoint a special settling day in, and to grant a quotation to Chelsea Electricity Supply Company, Limited, further issue of 12,000 ordinary shares; and to allow the following to be quoted in the Official List: Willans and Robinson, Limited, £100,000 4½ per cent. first mortgage debenture stock, in lieu of the provisional certificates now quoted.

Kensington and Knightsbridge Electric Lighting Company.—The ordinary general meeting for the adoption of the report and accounts was held yesterday at Westminster.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending February 21st, 1897, were £1,044; week ending February 23rd, 1896, £968; increase, £76; total receipts for half-year, 1897, £8,717; corresponding period, 1896, £7,914; increase, £803.

The Liverpool Overhead Railway Company. The receipts for the week ending February 21st, 1897, amounted to £1,320; corresponding week last year, £1,059; increase, £261.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending February 19th, 1897, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,282.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. †	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation, Feb. 17th.	Closing Quotation, Feb. 24th.	Business done during week ended Feb. 24th, 1897. Highest.	Lowest.
175,400£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	4 %	...	100 —104	100 —104	...	...
25,000	Amazon Telegraph, Limited, shares	10	...	...	...	8½— 9½	8½— 9½	...	...
1,812,880£	Anglo-American Teleg., Ltd.	Stock	£2 2s.	£2 9s.	£2 13s.	52 — 55 xd	52 — 55	53½	53
2,993,560£	Do. do. 6 % Pref.	Stock	£4 4s.	£4 18s.	£5 6s.	95½— 96½xd	95½ — 96½	96½	95⅝
2,993,560£	Do. do. Defd.	Stock	...	...	...	8½— 9	8½— 9	...	...
139,980	Brazilian Submarine Teleg., Ltd.	10	7 %	7 %	...	15½— 15⅝	15½— 15⅝	15 9/16	15½
75,000£	Do. do. 5 %, Debs., 2nd series, 1905	100	5 %	5 %	...	113 —117	113 —117	113½	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	2½%	4 %	...	3½— 3⅝	3½— 3⅝	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	...	170 —175	170 —175	...	...
224,350	Consolidated Telep. Const. and Main., Ltd.	10/-	1½%	1½%	...	1/16— 3/16	1/16— 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	...	12 — 13	11½ — 12½	12⅝	12½
6,000	Do. 10 % Pref.	10	10 %	10 %	...	19½— 20½	19½— 20½	20	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	...	3½— 4½	3½— 4½	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	...	10 — 10½	10 — 10½	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000	50	4½%	4½%	...	105—108%	105 —108 %	...	...
60,710	Direct United States Cable, Ltd.	20	2 %	2½%	...	9 — 9½	9 — 9½	9⅝	9⅛
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	...	17 — 17½	17 — 17½	17⅝	17 1/16
70,000	Do. 6 % Cum. Pref.	10	6 %	6	...	18 — 19	18 — 19	18½	18⅝
102,100£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	...	103 —105 xd	103 —105	...	...
1,397,837£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	130 —133	130 —133	130½	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd.	10	7 %	7 %	...	17½— 18	17½— 18	17 3/16	17 9/16
54,100£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	...	100 —104	100 —104	...	...
194,300£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	...	101 —104	101 —104	101	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	...	130 —133	129 —132	130	...
80,600£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	...	100 —104	100 —104	...	...
107,600£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	...	101 —104	101 —104	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	...	107 —110	107 —110	...	...
280,800£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	...	110 —113 %	110 —113 %	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4½%	4½%	...	11 — 11½	11 — 11½	11 7/16	11 3/16
180,042	Do. do. 6 % Pref.	10	6 %	6 %	...	17½— 17⅝	17½ — 17⅝	17⅝	17⅜
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜%	10 %	...	24½— 25½	24½ — 25½	25⅜	25
180,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	...	104 —107	104 —107	105	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	...	53 — 56	53 — 56	...	...
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	...	109 —112	109 —112	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000	5	4 %	4 %	...	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 %	5½%	5½%	7½— 7⅝	7⅝— 7⅝	7⅝	7⅜
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	17 — 19	17 — 19	17	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	17 — 19	17 — 19	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6⅜— 6⅞	6⅜— 6⅞	6⅜	...
1,100,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	104 —107	104 —107	106½	105
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	4½%	5 %	...	1/16— 1/8	1/16— 1/8	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	...	106 —109	106 —109	...	...
11,839	Reuter's Ltd.	8	nil	5 %	...	7 — 8	7 — 8	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	138 —143	138 —143	...	...
58,860	United River Plate Teleph., Ltd.	5	3 %	4 %	...	3½— 3⅝	3½— 3⅝	...	...
146,732£	Do. do. 5 % Debs.	Stock	5 %	5 %	...	100 —105	100 —105	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	nil	4 %	...	5 — 6	5 — 6	...	...
238,280£	Do. do. do. 5 % Debs.	100	5 %	5 %	...	103 —106	103 —106	...	...
30,000	West Coast of America Teleg., Ltd.	10	nil	nil	...	¾ — 1½	¾ - 1½	...	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	...	98 —104	98 —104	99	98½
54,248	Western and Brazilian Teleg., Ltd.	15	3 %	3 %	...	8⅜— 9½	8½ — 9	9	8⅜
33,129	Do. do. do. 5 % Pref. Ord.	7½	5 %	5 %	...	6⅜— 7½	6⅜ — 7½	...	...
33,129	Do. do. do. Def. Ord.	7½	1 %	1 %	...	2½— 3	2½— 2⅝	...	...
165,280£	Do. do. do. 6 % Debs. "A," 1880 Red.	100	6 %	6 %	...	110 —114	111 —115	114	112
206,400£	Do. do. do. do "B," do.	100	6 %	6 %	...	109 —113	109 —113	109½	109
88,321	West India and Panama Teleg., Ltd.	10	⅛%	⅛%	...	1½— 1⅝	1½— 1⅝	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	11½— 12	11½ — 12	...	...
4,569	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	9½— 10½	9½— 10½	...	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,800	100	5 %	5 %	...	107 —110	107 —110	...	...
1,777,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds	$1000	7 %	7 %	...	107 —112	107 —112	...	...
164,200£	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	...	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	4½%	5 %	6 %	9½— 10	9½ — 10	9 15/16	9⅝
10,277	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277	5	5 %	5 %	5 %	8½— 9	8½— 9	...	...
60,000	Do. do. do. 4½ % Deb. Stock Red.	Stock	...	4½%	4½%	112 —115	112 —115	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	5 %	5 %	7 %	17 — 18	19 — 20	19⅝	18
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	16½— 17½	17 — 18	17½	17
300,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	129 —133	133 —137	135½	132½
22,475	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—22,475	10	...	nil	nil	9⅜— 10½	10¼— 10⅜	10½	10
20,000	Do. do. do. 6% Pref., 40,001—50,000	10	...	6 %	6 %	14 — 14½	14½— 15	14⅝	14⅝
10,000	Do. do. do. iss. at 2 pm., all paid	10	...	...	...	10½— 10⅝	10⅝— 11½	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000	10	3 %	4 %	...	13½— 14½	13½— 14½	14 3/16	14
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem., £1 paid	10	...	...	...	7 — 7½	7½— 8	7½	...
150,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	...	119 —122	120 —124	123	122
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	1 %	2 %	4 %	11 — 12	11 — 12	...	...
19,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	6½%	7½%	10½%	12½— 13½xd	13 — 14	14	13½
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9½— 10½xd	9 — 10	10	9 7/16
50,000	Do. do. 4 % Deb. stock Red.	Stock	...	...	...	104 —107	104 —107	...	...
67,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000	5	5 %	7 %	9 %	11½— 12½	12½— 13½	12⅞	12½

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless therwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

§ Dividends marked § are for year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation Feb. 17th.	Closing Quotation, Feb. 24th.	Business done during week ended Feb. 24th, 1897. Highest.	Lowest
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	3	2½%	...	...	⅞ – 1⅛	⅝ – ⅞	1⅛	⅞
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	3 %	...	...	1½ – 1⅝	1½ – 1⅝	...	...
125,000£	Do. do. 4½ % Perp. Deb. Stock.	Stock	4½%	...	...	109 –112	109 –112	...	...
76,770	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	94 – 98	94 – 98	...	...
9,104	Central London Railway, Ord. Shares	10	...	...	...	9½ – 10	9½ – 10	9⅞	...
207,649	Do. do. do. £6 paid	10	...	...	...	5½ – 6	5½ – 6	...	...
630,000£	City and South London Railway	Stock	1½%	1 5/16%	1 5/16%	59 – 61	59 – 61	60½	59⅝
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	*nil*	*nil*	...	1⅜ – 2⅛	1⅜ – 2⅛	2 1/16	1 15/16
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	5 %	5 %	...	1⅜ – 2⅛xd	1⅜ – 2⅛	...	...
17,139¶	Do. do. do. "A" Shares 01—017,139	5	5 %	5 %	...	3 – 4 xd	3 – 4	...	...
100,000	Do. do. do. 4½% Deb. Stock Red. ...	Stock	4½%	4½%	...	105 –110	105 –110	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	5 %	...	1½ – 1⅝	1½ – 1⅝	1 11/16	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	...	2⅛ – 3	2⅛ – 3	2⅛	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	...	...	⅝ – 1⅛	⅝ – 1⅛	...	...
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	...	...	⅜ – ⅝	⅜ – ⅝	...	..
9,600£	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	*nil*	10½%	...	10½ – 11½	10½ – 11½	...	...
10,000	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	6 %	8 %	10 %	19 – 20	19½ 20½	19⅝	...
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	18½ – 19½	18½ – 19½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	4½%	4½%	109 –114	109 –114	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	10 %	10 %	10 %	21 – 22	21 – 22	21 13/16	21⅜
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	106 –109	106 –109	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	1½%	2⅞%	2⅛%	13 – 13½xd	13 – 13½	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	16 – 16⅝xd	16½ – 16⅝	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	15 %	39 – 42	39 – 42	41	40½
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102 –105	103 –106	...	...
54,000£	Waterloo and City Railway, Nos. 1 to 54,000, £8 paid ...	10	...	...	...	10 – 10½	10½ – 10⅝	10⅝	10½

Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1900.
Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.
CROMPTON & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%/52; 1891—7%/52; 1890—6%/

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), 7⅞, £5 (fully paid) 9.
Electric Construction Corporation, 6 % Debentures, 103 –105.
House-to-House Company (£5 paid), 5—5½.
Do. do. 7 % Preference, of £5, 8⅜ – 9½ xd.
Do. do. 4½% Debentures of £100, 108 – 110.

Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 10½—11; 1st Preference Cumulative 6 %, £5 (fully paid), 8½—8⅝. Dividend, 1896, on Ordinary Shares 7 %.
London Electric Supply Corporation, £5 Ordinary, 1½—1⅝.
Yorkshire House-to-House Electricity Company. £5 Ordinary Shares fully paid, 7—7½ xd. Dividend for 1896—7 %.

* From Birmingham Share List.

Bank rate of discount, 3 per cent. (February 4th 1897).

SOME NOTES ON STEAM RAISING.*

By FRANK LESLIE WATSON, Assoc.M.Inst.C.E., Leeds.

PROBABLY no subject is of much greater importance to the manufacturer in these days than the reduction of his coal bill, and the methods adopted for obtaining this reduction may be roughly classified thus:—

1. Improvement of the boiler plant.
2. Improvement of the engines.
3. Improvement of the mill gearing and machinery.

Although there may be some doubt as to the order in which Nos. 2 and 3 should be arranged, it appears to me that there can be none whatever as to the paramount claims of the boiler plant to be considered first, for the reason that £50 spent on the boiler will in many cases save more money than £200 spent on the engine. But it is usually found that the whole attention of the firm is concentrated (so far as the coal bill is considered at all) upon the improvement of the engine, leaving the boilers and mill gearing to look after themselves. And we find the over-worked boiler, perhaps a 30′ × 8′ Lancashire boiler, with 3 feet flues, burning good slack at 6s. or 7s. a ton, or, perhaps, even large coal at 9s. or 10s., on bars 1¼-inch thick with 1 inch spaces, and letting about a third of it fall through unburnt; the boiler discharging volumes of smoke into a little stack that was built when a 10 H.P. Cornish boiler ran the mill. In such a case as this it is useless for the owner to propose the use of a cheaper fuel; the stoker says it's hard enough to keep steam as it is: when he is not throwing on coal, he is cleaning his fires, and when he is not cleaning them, he is breaking them up. He thinks he could do better if he had a mate to wheel out his ashes and hold the fire-door open for him. The master does not see this, so the boiler insurance man is consulted next time he comes round, and he (disinterestedly, of course), recommends the adoption of somebody's patent grate-bars. He happens (quite by chance) to have one of their circulars in his pocket, and the circular sets forth that somebody has spent a lifetime and a large fortune in perfecting these bars, and they are now guaranteed to admit nothing but pure oxygen to the fire, to save 25 per cent. of the coal, and to make 25 per cent. more steam, and to render it impossible to make smoke. These bars appear to differ from ordinary ones mainly in having spaces of some weird shape, which is credited with wonderful virtues; the spaces are only ⅛ an inch or ⅜ths inch wide, which is a distinct improvement, but the stoker shakes his head, and says that means more work for him, for if the ashes don't fall through, he says he will have to rake them off the top. The bars are probably three times the price of ordinary bars, but the master thinks the oxygen business sounds well, and the stoker is well lubricated, and the bars go in. They undoubtedly save some fuel, owing to the finer spaces, but they don't prevent the smoke, and unless the lubrication of the stoker is regularly continued, the next set of bars are probably ordinary ones with equally small spaces, which are found to answer as well as the patent bars. Perhaps the next thing to be tried is a mechanical stoker, and this may, in favourable circumstances, and where there are plenty of fitters hanging about with very little to do, be found to work all right. But I have come across quite as many failures of mechanical stokers as successes, and I have in mind one case where, on a range of 10 boilers, which have been working about three years, they have scrapped two complete sets of mechanical stokers, and have the third set (of a different type) in use, but still under the makers' maintenance contract, and the makers' fitters are never off the job. The fact is, the ideal mechanical stoker is not yet made.

We will suppose that our manufacturer has no spare fitters, and that when the mechanical stoker gets out of order, it stays out of order, and then we find the fires being worked by hand through the door of the machine, which is far too small, and the temper of the fireman is such that no amount of lubrication suffices to keep that mechanical stoker off the scrap heap. After this, our manufacturer gives general orders to the cashier that he is too busy to see any person representing patent furnaces for boilers, and writes to the papers to say that he has tried all sorts of smoke preventing appliances, and there is nothing but trouble and expense connected with them; and I believe this to be the present frame of mind of a large number of steam users. The cause of most of the trouble is insufficient draught; and by improving the draught in a judicious manner a very great economy can usually be effected.

The three things needful for perfect combustion, and consequent smoke prevention and economy, are:—

1. That a sufficient quantity of air should be supplied to the furnace; and
2. That this air should be supplied at the proper place or places;
3. That when perfect combustion has been attained, the greatest possible quantity of heat must be abstracted from the gases before they are permitted to go up the chimney.

To secure the first point, namely, a sufficient air supply, a good draught is required, and a high chimney is an unquestionable method of obtaining a good draught. But a high chimney has a disadvantage, due to its operating at the wrong end of the system. The chimney works in this way: First the ascending hot gas in the chimney causes a partial vacuum, or to use a good practical word, a "suction" at the bottom of the stack. If there is no easier road in,

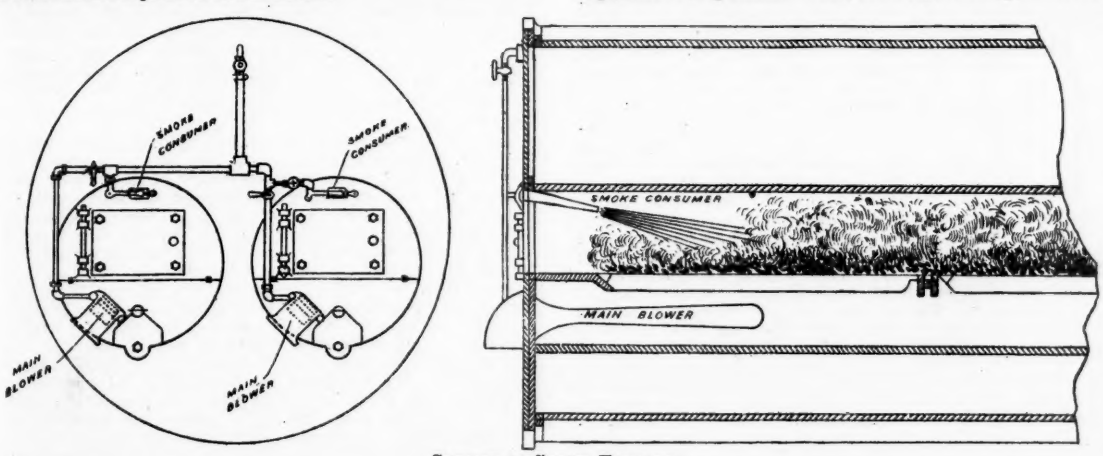
* Paper read before the Association of Yorkshire students of the Institution of Civil Engineers, February 18th, 1897.

this suction draws the gases out of the flues, and creates a "suction" over the fire, which, if the firing door be tight shut, draws the air through the fire; if, however, the firing door be open, volumes of cold air rush in and cool down the flues, and in the case of a hard fired boiler, the firing doors are open a large part of the time. Thus in the case of suction draught, all the leaks are against you, and your chimney may be designed to pull the proper quantity of air through your fire; but it will not pull it through the fire if it can pull it through anywhere else. Whereas, if you close your ashpit, and force in the proper quantity of air, it has no option but to go through the fire, and thus half an inch of pressure under the bars will do as much good as an inch of suction at the chimney.

Do not, however, think that I am arguing for an essential difference between what is called "induced" and what is called "forced draught." The current of air through the fire in both cases is due to the fact that there is a higher pressure under the bars than above them, but in the one case the higher pressure is that of the atmosphere, and exists outside the firing doors and all round the boiler, while the lower pressure must be considerably below the atmospheric; while in the other case (if the closed ashpit be used), the higher pressure is considerably above that of the atmosphere, and exists only in the ashpit, and the lower pressure is only very slightly below the atmospheric, and there is practically no tendency for the air to pass by any other route except through the fire. The case of the "closed stokehold" system of forced draught, on the other hand, is exactly the same as that of chimney or suction draught, except that all the pressures are slightly higher up the scale. The "closed ashpit" system of forced draught is preferable, on account of the fact that on this system the minimum quantity of cold air is admitted during the feeding operations.

I am of the opinion that the highest economy is obtained when the quantity of air supplied is the smallest possible quantity which is consistent with complete combustion; in fact, if the combustion be not quite complete, the loss is generally less than if complete combustion be secured by means of a large excess of air. Some excess of air, however, is a practical necessity if there is to be no smoke, and this brings me to my second point, namely, that the air must be introduced at the proper place.

If no air be admitted by any other way but through the fire itself, it will never be a very easy task to prevent smoke with smoky coal, though I am inclined to think that with a very good draught, the greatest economy is obtained by admitting no air except through the fire, because in this case the quantity of air admitted per pound of coal burnt can be kept down to a minimum.



Section of Loidis Furnace.

An additional air supply must, with smoky north country coal, be used for smoke prevention, and the point to be determined, is how that air supply shall be admitted?

It must be remembered that we require not only to bring the air in contact with the half burnt gases, but to bring them together under such conditions that the unburnt gases shall seize upon the oxygen of the air and become thoroughly burnt; that is to say, they must be brought together in the presence of a high temperature. Take the case of a Lancashire boiler, provided with the ordinary opening in the bridge, provided with a door for admitting air to the flue beyond the bridge. We will suppose this boiler to be fitted with Galloway tubes, and that the Galloway tubes are as usual too close to the bridge. We have here the necessary mixture of hot gases and air, but the boiler makers have thoughtfully provided a pair of tubes full of comparatively cold water, to cool down the gases to such a point that they cannot possibly combine, and an analysis of the chimney gases in this case would show the anomaly of unburnt gases in the presence of an excess of air.

Of course, there are better arrangements of split bridges than this, and if there is a good draught and the cross tubes are either left out or taken far enough away from the bridge, very fair results may be obtained with good stoking. Results which will not entail prosecution may even be obtained by means of the ordinary perforated door, if the firing be easy and regular; but it should be remembered that the time when the excess of air is required is after firing, when the fire is giving off huge volumes of gas, and the gas thus given off is generally sufficient to satisfy the demands of the chimney, so that the quantity of air drawn in through the door is least just when it should be greatest.

The same effect is produced in regard to the air drawn through the fire by a mechanical suction draught; the large volume of gas given off by a black fire reduced the suction, and the greatest volume of air is consequently passed through the fuel when it is in the bright, or partly burnt out condition, and therefore it is expedient to use a system of draught which can be in some way controlled, and we have such a system in the case of forced draught.

Whether a fan or rotary blower be used, or whether a steam jet be used, the blast can be so controlled as to give the greatest quantity of air to a black fire, and the least quantity to a bright fire; and precisely the same train of argument holds good in the case of the secondary air supply, which is introduced specifically for smoke prevention. This should also be so arranged that the quantity of air admitted can be greatest for a black fire, and can be reduced to a minimum for a bright fire. I prefer to admit this secondary air supply over the firing door, either by means of a branch from the blast pipe if a dry air blast be used, or by means of a small steam jet blower if a steam jet forced draught be used.

In early smoke consumers of this type the air pipe was placed horizontally; this has the disadvantage that the air is simply propelled along the upper part of the flue, in contact with the cold plates, and thus its object is to a great extent defeated, the combination of the gases being retarded or prevented in a similar manner to that described with reference to the Galloway tubes. The proper plan is to slope the air pipe downwards, so that the additional air supply is delivered into the heart of the fire and thoroughly mixed with the gases of the fire when at their highest temperature, and thus the combination of the air with the hot smoke can be best secured.

In the furnace shown in this illustration, an attempt has been made —so far with great success—to secure the benefits of "forced draught," namely, increased duty from the boilers, combined with the prevention of smoke. The forced draught is obtained by means of a steam jet blower, of special construction, under the grate, while an additional blower of similar construction is provided to give the additional air supply over the grate for the complete combustion of smoke. These two blowers are found not to impede the action of one another in the least, so that we have got rid of one important defect in most "smoke consuming" devices, namely, that when the smoke consumer is working the draught is impeded or destroyed. To show that this is no fanciful objection, I may mention that I have come across numbers of cases where various smoke consuming devices have been tried and abandoned, not because they did not stop the smoke, but because they *did* stop the draught, and rendered it difficult or impossible to keep steam. When, however, two independent blowers are used, one above and the other below the grate, provided with proper means of control, it is possible to vary the quantities of air delivered by each according to the quality of fuel or according to the state of the fire, and to consume the smoke without any great sacrifice either of efficiency or of output, as compared with a similar forced draught furnace without the over-grate blower.

The first form of steam jet introduced was doubtless the plain round nozzle, and many patents have been taken out for jets which were intended to be more economical than the common form. I think it is generally held that the action of the steam jet is almost entirely due to surface friction between the steam and the air, though one maker has written letters to the papers in support of the "continuous piston" theory, and I believe acts upon that theory, and cuts off his trumpets at the neck, on the assumption that once the steam has got through the neck it can do no more good.

Following, however, the friction theory, people have made ring jets, in which the outside only is in contact with the air; in this case, the efficiency should be slightly increased. Then followed ring jets in which the air was admitted to the inside as well as the outside of the ring, and of this class is a blower which is very commonly used on gas producers. This system certainly has the merit of letting out the steam in a thin stream, and securing a large surface of contact; but the small area of the air way through the centre renders it not of much value, comparatively speaking, and the inner cone, especially in adjustable jets of this class, gets out of centre, and the jet then blows all to one side, which is a very vicious state of things.

A better form is the Argand, in which a number of small jets are arranged in a ring; but this is not adjustable, and is not very easy to

make so, and the small holes are apt to wear larger. Obviously, the correct thing is to make the steam jet flat, and my firm have a patent for the construction of adjustable flat jets, of which a sample is shown.

We have constructed jets on this principle, varying in width from 1 inch to 26 inches, though, of course, in the large sizes a slightly different method of adjustment has to be adopted.

The adoption of these improved jets by my firm for use in the Horsfall destructor has resulted in a saving of 33 per cent. of the steam used by the round jets formerly employed.

(To be continued.)

A FEW PRACTICAL NOTES ON ALTERNATE CURRENT SWITCH-GEAR.*

Discussion.

The President said: They had been extremely interested with the various ingenious contrivances and devices described, and he was pleased to see that the author recognised that the ethics governing a central station were those that should always obtain where two or three were gathered together working for the common weal. It would not do at all if a large generator, for some reason, took it into its head to strike work, and call out the other workers in the shop by blowing their fuses. Just because the machinery of an old goose had got out of order, it was not at all right that she should turn round on the young healthy ones, who were prepared to go on at an increased rate, if necessary, laying the golden eggs of supply. However, as there were several gentlemen in the room who were connected with alternating stations, they would be very pleased to hear their remarks on the best way of getting over the evils by keeping the generator up to its work. He must also ask those gentlemen, who had *not* charge of alternators, to give them their impressions as to what they would do if they *had*.

Mr. Ferranti said he would give his opinions as an outsider, or one who was connected with an alternating station once upon a time. He did not know whether, in listening to the author's paper, any of the members realised the immense amount of work that must have been done by Mr. Andrews to get at the results which he had described. It showed a very distinct train of thought, which had been carried over a long period, and which was undoubtedly engendered by certain special circumstances of the case he had had to deal with. There were other stations in the country working on somewhat the same system, but different in their detail, where he thought that if Mr. Andrews had been in charge, he would never have devised the ingenious system which he had shown them that night. He believed, with regard to the first point, that it was customary at a good many stations to synchronise with small fuses. These were the stations employing alternators without iron in the armature of very low self-induction, and where the machines could give a dangerously large rush of current if the synchronising was badly done. He thought that stations such as those put up by the Electric Construction Company and Fowler's, had in no cases attempted those fuses, as the current on putting into parallel badly was not such a serious matter as with the other type of machine. For his part, he did not think that if stations had reasonably good plant, they should think of the synchronising fuses. With regard to synchronising, he would say that, so far as he had seen, the nicest way of getting into parallel was to have the revolving part of the machine painted with as many white lines or spots as there were field poles. If they then lighted the station with alternating arc lamps, fed from the bus bars, the lines would be seen to revolve backwards when the machine was at less than synchronous speed, forward when it was above, and to stand still when the speed was synchronous. The great advantage of this method of synchronising (of course assisted by voltmeter and lamps) is that one can see if one is running too fast or too slow. The engine driver has the most perfect knowledge of what is actually taking place with the plant of which he has charge, and he regulates it accordingly. The switchboard attendant need not bother himself whether it is going too fast or too slow. The switch-man regulates the exciting current, and the driver regulates the actual speed at which the plant is being run, in accordance with the moving diagram which tells them in plain language what the plant is doing. This method is already in use at the Portsmouth station, and it is being introduced into several other stations where the switchboard was so far from the dynamos that it was difficult to communicate. With regard to what Mr. Andrews said about Mr. Raworth having devised a sort of zero arrangement, one which discriminated whether the current was going the right or wrong way, he found that a good many people had taken it up independently, and had said nothing about it. Struggling with the same question about ten years ago he constructed apparatus for accomplishing this work, and believed the method was exactly the same as Mr. Raworth's, and he never put the apparatus into use, as he had quite enough things about the station without producing any more. Mr. Andrews mentioned a most important question about danger on the switchboard. There was no reason why a switchboard gallery should be particularly dangerous, but he thought on the other hand one might err on the side of enclosing it too thoroughly. So far as he could see, the only arrangement which lent itself to complete enclosing was that where the switchboard had a back to it, which involved far greater danger to life, and also risk from fire. It was at the back of the switchboard that the unfortunate man was killed at Hampstead. Water break switches were very interesting. He was at Paris last week, and had the pleasure of seeing some water switches which had been in use for many years. They broke one of the switches on 2,400 volts continuous current, which was far more difficult to break than alternating. He did not see any sparking at all, and it worked most beautifully. With regard to the arrangement in diagram 3, with one exception it was almost identical with Mr. Rider's arrangement at Bolton. The switchboard there was, he thought, made by the Manchester Edison-Swan Company to Mr. Rider's design. It was quite possible Mr. Andrews may have found his arrangement (after sufficient experimenting) to be a satisfactory means of stopping the arcing from the switch, and it might be that the combination of adding this piece to it would cure the difficulty which would otherwise exist with that form of switch. Mr. Andrews had called their attention to the connections of his switch gear, and showed that he used a supplementary bus bar. An arrangement something of that kind had been put into use upon most of the switchboards similar to those at the House-to-House Company, West Brompton. It consisted of two complete bus bars, and the machines and circuits were arranged so that they could be put on to either. They could then have their station working on two separate circuits. The Leeds House-to-House Company had that arrangement for one. A recent case was that at Edinboro', where he believed it was devised quite independently by Prof. Kennedy, so that if he could not synchronise machines quickly enough when fog came over, he would then be able to throw any circuit on to the spare bar or a couple of circuits, and then run up a new machine on it. That was precisely the same idea, but without the special gear to bring the extra parts into action. It was purely a system of two bus bars, and they could work the results by hand instead of automatically. There was one point which he did not agree with at all, and that was the exciting of alternators by one common exciter. He very much preferred to get each machine with its own exciter, and he had bought exciters from different makers, and he was pleased to tell them that he had never had a failure on an exciter of any alternator which he had had at work. He had bought what he thought the best machine he could buy, had allowed probably 50 per cent. margin, and he had never had a single failure with exciters. There was one point in which he agreed partially, and, perhaps, disagreed with the author also, and that was the question of a diagram on the switch gallery. He thought it was a most vital thing that any one coming into the station should know at once exactly what the connections of the switchboard were. He did not like to understand a switch gear one day, and a year hence have to look it up again. He thought so far as possible that the switch gear should be absolutely its own diagram, and that upon the face of it they could see exactly the meaning of all parts. With regard to the question of alternators, why Mr. Andrews had put in so much work in devising that ingenious and useful apparatus was because he had been unfortunate enough to have plant which required being dealt with in this delicate manner. Alternating electric supply was becoming very much more reliable than it used to be, probably due to the stations being equipped on reasonable and engineering lines.

Mr. E. W. Cowan said he would like to make a few remarks on the paper, which he had listened to with very great interest. The first point was with regard to using the use of an auxiliary fuse for paralleling. Such an arrangement enabled the synchronising and paralleling to be done at the synchronising panel, supposing they had a separate panel for the purpose. He had tried using a coil with large self-induction instead of a fuse, and then switching this in between the two machines, and not troubling whether they were in phase or not, but letting the current flow between the machines through the self-induction until they brought each other into phase; but it did not seem to be a very necessary apparatus for iron cored alternators. Mr. Andrews said that he used a magnetic cut-out because it was quicker in its action than a fuse; he looked upon it as being slower. The instrument which the author had described had a certain amount of inertia, and it seemed to him that it must be slower in its action than a fuse. Mr. Andrews has described his exceedingly interesting apparatus, which he thought it would be hard to beat for ingenuity. It had given him great pleasure to hear the way in which the author had overcome the difficulties of dealing with the effect of short circuits on the mains, especially the way in which he had avoided any complications, it was an exceedingly good arrangement, and very much to his credit. Mr. Andrews considered that for the prevention of accidents, the design of alternating switch gear should be such that injury from shocks would be practically impossible, and that all parts carrying high tension current should not be exposed; he heartily agreed with him. He believed that almost from the first his firm had tried to design all their fittings so that there would be no parts exposed. With regard to the high-tension switch which Mr. Andrews referred to as one which he was experimenting with, and which Mr. Ferranti also spoke of, he might say that that switch was designed in their drawing office a few years ago, and was proposed to Mr. Rider of Bolton as an alternative to the Fowler switch which he had specified. Mr. Rider accepted the switch, and they had made a good many for use throughout the country. There was no doubt that, as Mr. Ferranti pointed out, the switch had a possible tendency to arc, but at the same time he might say they had not had any arcing, and he considered they were quite safe at the full current though not on a short circuit. The switch was similar to that shown by Mr. Andrews; the contacts were not mounted on marble, but on ebonite. In their later designs they had added a shutter, and it had an advantage in preventing the switch being closed when it ought not to be. On the whole question of using this apparatus, he was inclined to agree with what Mr. Ferranti had said, that it had been devised for special circumstances, but it seemed to him that in cases where they had alternators which were not iron cored, that some sort of apparatus such as this, if it could be made with perfect reliability and simplicity and durability, was an apparatus which should be used in every station of that kind. Then a question which

* Paper read by Mr. L. Andrews before the Northern Society of Electrical Engineers, January 25th, 1897.

it was very difficult to decide arose in the case of iron cored alternators. They had an iron cored alternator at Altrincham, which probably would give in proportion to its size as much current in excess of the normal as a non-iron cored, and they consequently got excellent regulation with that alternator. They had other alternators only giving about 100 per cent. in excess of the normal current on short circuits, and these alternators would hardly blow the fuses if they had a short circuit on the mains. Which was the better machine? Suppose they had a breakdown on one of the machines running in parallel, the result was not disastrous, the light was very quickly steady again, and no harm was done by overloading the remaining machines. One question which Mr. Andrews had raised was the question of being able to switch any alternator on to any circuit; that he considered a very important and necessary arrangement, and they had got out an arrangement by which they could plug any alternator to any circuit, and when they had the machines running in parallel on the circuits, all they had to do was to adjust the plugs, and then the opening of the alternator main switches left these machines running on different circuits. They had their plug connections made on the alternator side of the alternator switches and the circuit side of the circuit switches, and when they had the different machines plugged on to the different circuits, the machines could be very rapidly taken out of parallel if there happened to be a breakdown of one of them. As to exciting alternators from separately driven exciters, he quite agreed with what Mr. Ferranti had said. One objection to the separately driven exciter was that it meant two small additional auxiliary engines, one of which at least had to be kept running during the hours of light load, and there resulted all the waste which must accrue by the use of an auxiliary plant. As to using storage batteries, he considered it was very expensive, but a very good arrangement otherwise. He instanced a case which he knew of where the breaking of glass cell in an exciting circuit battery had caused a failure of the light.

Mr. Wordingham said: The design of switch gear for central stations would of necessity vary with almost every station, and it must therefore be specially worked out in each case. It was no reproach to the author to say that this was a special arrangement. They had his assurance that all those apparent complications had worked without a hitch; but, for his own part, he always mistrusted automatic apparatus—it had such a way of wanting a man to work it. He did not think it was possible to have switchboards too simple, and Mr. Ferranti had used the very words that he (Mr. Wordingham) would have used in saying that the switchboard should be its own diagram. They did not want to be looking out diagrams while an armature was burning out; they wanted to look at the board, and not be able to make a mistake. They wanted an intelligent man—something between Mr. Andrews specially-trained man and an ordinary labourer—they did not want him to have to spend a lifetime learning the switchboard. The author referred to the reputation of continuous current for continuity of supply over alternating. Perhaps that arose from other reasons than the zero cut-out, because some stations used fuses made of copper, and which were of the same sectional area as the mains themselves; that, he thought, tended towards continuity of supply. He quite agreed with the author as to the prevention of accidents to the attendants with high tension switch gear; the negligence in some stations was simply criminal. He had visited some in which any person might walk up against the apparatus. His own view of high tension switch gear and high tension apparatus, was that it should be so guarded as to make it impossible for any man to get a shock; he did not think too much money could be spent to attain this object. He thought that any part of the switch gear which had to be handled should be connected to earth, so that the man would be absolutely safe in whatever he took hold of. It was always a difficult matter to carry out this arrangement for safety, and to allow at the same time for the proper cleaning of the switch gear. The contact parts had to be cleaned, and special arrangements should be made to enable this to be done without risk to the attendant. The necessity for a man to stand on an insulated platform or stool, ought, he thought, to be avoided as far as possible. There was one point about the switch and shutter. Asbestos was a very treacherous material in his opinion; certainly he did not think it would prevent a man from getting a shock. It might prevent his poking his fingers between the contacts. The switch described by Mr. Cowan, in which the contacts were sunk below the surface of a piece of slate appeared to him to somewhat resemble the dynamite engine, in which a new engine was required with each explosion.

Mr. Andrews in reply said: With regard to Mr. Ferranti's and Mr. Cowan's remarks about iron-cored machines, he would like to ask if, when these iron-cored machines are switched on very much out of phase, they do not make the lights jump. At Hastings they had Mordey machines to work with; some engineers considered this to be a misfortune, but he did not agree with them. If these machines were switched in out of phase they only made the lights jump, the machines were not injured, but it was just this jumping of the lights that they objected to. They would rather lose two or three coils than have the lights jump badly. He referred to a modern station where iron cored alternators were used, and where quite recently an engine driving one of these machines had suddenly failed, thus short circuiting the omnibus bars and totally extinguishing a large number of lights. The machine was not damaged, but the Supply Company's reputation was, which he considered far more important. This was a specimen of many recent interruptions which might have been prevented by the use of a return current cut-out. As regard exciting in parallel, he had always been accustomed to run alternators excited in parallel until he went to Hastings, where they were then excited from separate machines. The first day or two he was there he wanted to change over from a 50 kw. machine to a 100 kw. set. He thought they had only about 30 amperes maximum load on the station at that time. He got the 100 kilowatt plant in parallel, and ran it up slowly, letting the other one down. The current came up on the 100 unit machine pretty quickly to about 70 amperes, and on the other it went up to considerably over 30 amperes, and he could not get the current lower on either machine anyhow. He ran up the engine of one and then the other, and looked at the ropes to see which was motoring and which was generating, but could not tell. At last the little machine began to smoke, and he thought the only thing to do was to switch out. He switched out at about probably 40 amperes. The arc did not break, but burnt the whole board up, and all the lights went out. He found afterwards that the whole trouble was caused by the machines being unevenly excited. He promptly had arrangements made for exciting the fields in parallel, and since then he had experienced no further trouble. With regard to the diagram on the wall, he quite agreed in having the switchboard the diagram itself, and he had spent a great many hours in designing the Hastings switch-gear, in order to get the wires in that way, so that they could be instantly traced out. Each of the wires at Hastings was run up the surface of the wall. Nevertheless he liked the diagram, because they could not always see the connections under the instruments, and if, as sometimes occurred, things went wrong, he did not think that the diagram should be far away from the switchboard. He, himself, found it exceedingly useful, and he could not see any objection to it. Mr. Cowan spoke of fuses being quicker in their action than magnetic cut-outs. He had found that fuses took a perceptible time to go, whereas magnet cutouts cut out instantly. They could see from the diagram A and B, fig. 6, how very rapidly it acted; it clearly showed only one-tenth of a second had elapsed between the rush of current and the circuits being interrupted; a fuse could not go quicker than that. With regard to magnetic cutouts being easy to reset, they could be reset at the rate of 30 times per minute, and he did not think fuses could be reset anything like so rapidly. If they wished to get machines in in a hurry, they simply stood at the switch and pumped it indiscriminately until it stayed in; this enabled them to get machines into parallel under very difficult conditions. Mr. Cowan referred to the question of synchronising after they had got past the steady phase. He said he did not think this method would apply to machines with heavy revolving parts; he (Mr. Andrews) did not think any machine had heavier revolving parts than the Mordey machine. He referred to C, fig. 6, which he thought clearly showed there was absolutely no rush of current when machines were switched in in this way, and they never got the slightest flicker in their lights. It was not necessary that the asbestos shutter criticised by Mr. Wordingham should be a perfect insulator to prevent accidents, because it did not touch the high-tension contacts. It merely served as a guard to prevent the contacts being touched. The author had suggested asbestos because it would not burn, at least he had not yet experimented with it far enough to burn it. He mentioned just now that it was only a crude idea. The arrangement he was now experimenting with was almost precisely the same as that described by Mr. Cowan; viz., a guarded shutter working with a spring.

On the motion of the President, a hearty vote of thanks was accorded to Mr. Andrews for his paper.

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

Electric Interlocking the Block and Mechanical Signals on Railways. By F. T. Hollins, Member. Paper read January 28th, 1897.

(*Continued from page* 262.)

Sykes's Signal Reverser.

In some cases it is desirable for the train *itself* to automatically place the advance signal to danger, independently of the signalman. A Sykes's signal reverser is fixed between the balance-weight lever and the signal arm, and moves with the upright rod when the arm is lowered. On the train passing over the rail contact, part of the current transmitted therefrom is used to discharge this signal reverser (and the arm goes to danger), at the same time as the back lock of the lever is released in the signal box. On putting back this lever (which is then locked), it re-engages with the reverser, ready for lowering for the next train.

Figs. 22, 23, and 24 show this reverser in its three positions. In figs. 22 and 23 the signal arm is lowered, and, on the train passing over the rail contact ahead, a current is transmitted through the electro-magnet coils, M, which attracts armature, A, and releases the hammer, B, and this, falling on rod, C (see fig. 23), disengages the catch, D, from roller arm, E; and slide, F, being bevelled, the top weight of the signal arm, the rod and the apparatus, falling, by gravity, and raising the signal arm, forces the roller arm, E, to assume the position shown in fig. 24, where the hammer is again caught up by the armature, A. When the signalman replaces his lever, the slide, F, moves downward, and the roller arm is caught up by the catch, D.

The apparatus is simple, works satisfactorily, and deserves to be more largely used.

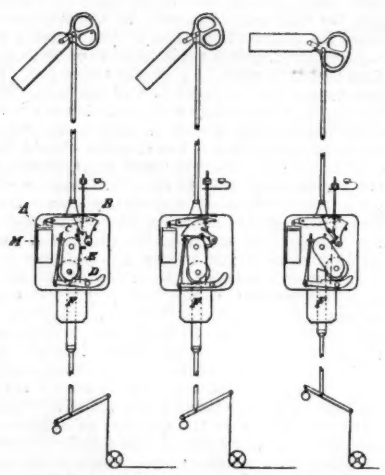
Siding, Junction, and Cross-over Working.

No system of electric interlocking can hope for very wide application that does not specially commend itself, not only for ordinary through working (which is comparatively easy), but as equally safe and applicable for siding, junction, and cross-over working.

On the Great Eastern Railway we have found Sykes's system specially suitable, and we have largely taken advantage of its facilities by providing, I believe, the most complete arrangements yet devised for avoiding mistakes at such points.

Junction Interlocking.

At junctions of converging lines, with very short sections, whilst the ordinary electric interlocking prevents trains being simultaneously accepted from both lines, the locking instruments are so interlocked with the points, that the points for a down road must be set so that an up train accepted could not possibly cross the path of a down train, and *vice versâ*.



Figs. 22. Fig. 23. Fig. 24.

Diagram fig. 25 will best illustrate what is meant. All the through lines, sidings, carriage roads, &c., are left out; only the lines concerned being shown, and the one signal referred to. Now (with reference to fig. 25), before Central Junction can plunge to accept, and unlock the section signal for, an up train from Polygon, he must set his down local points for down local to main, so that a down train could not possibly pass across the path of the up train accepted from Polygon.

When this point lever, 1 (fig. 26), down local to main, is back in the frame, the small lever, 2, on the instrument shelf is unlocked. Pulling over this small lever unlocks the plunger, 3, by raising rod, 4, enabling the up train to be accepted; but the same motion of the small lever, raising the locking piece, 5, on the rod, 4, into the slot, 6, in the tappet, 7, mechanically locks the down points as set; and at the same time the armature, 8, is raised up to the coils, 9, and the small wheel, 10, passing under the angle piece, 11, on the rod, 4, this small lever is itself, as well as the points, electrically locked. He may now plunge to accept the up train, and he can neither alter the points, the small lever, or the plunger, until the train has passed a rail contact at point, A (see fig. 25), on the platform line, and is either

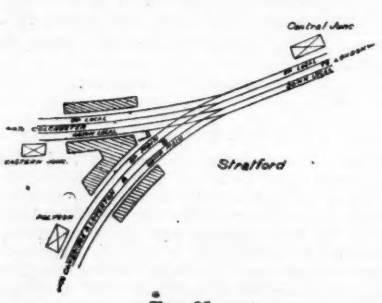


Fig. 25.

standing at the starting signal, B, at *danger*, or, if the latter is "off" (which would then mechanically lock the same points, and be itself back-locked electrically), until the tail of the train has arrived well over the down road, and the signal again put to danger behind it. The small lever, being unlocked by the current from the rail contact at A, and the starting signal at B being to danger, the points may be altered to down local; but this, by preventing the rod, 4, from being raised (it cannot be unless the locking piece, 5, coincides with the slot in the tappet, 7), again locks the small lever, and prevents another up train being accepted from Polygon. This arrangement is essential, because, being at a platform, we may require the train to stand there, with the signal at danger, so that a train *may* be allowed to cross its path on the down local.

At other nearly similar converging lines, but not at a platform, the signalman is compelled to lower his home signal for one line (which, of course, mechanically locks the lever of the home signal for the other converging line, and the signal for the opposite road, that would cross its path) before he can plunge to accept a train in either direction. And such home signal being lowered enables the signalman to plunge, and unlock the starting signal, for the same line, at the rear box; but the plunger and the signal alike remained locked in that position until the train so accepted has arrived and passed over the rail contact at the clearing point.

Sidings and Cross-Over Connections.

Again, in the case of sidings and cross-overs, this same electrical and mechanical locking between points and plungers comes in. If a train has been plunged for—that is, the rear box starting signal electrically released—the points leading from the sidings to the up line are locked. But if the points are already over for a train from the sidings, then an up train cannot be accepted from the rear. And if the train from the sidings requires to cross over to the down line, if the points are so set, a down train cannot be accepted; but if a down train *has* been accepted, the cross-over points to the down road cannot be got until the accepted train has passed, and the road is clear.

Crossing Trains from Down to Up or Up to Down Lines.

Here, again, is another application of interlocking between points and section plunger. A small Sykes's lever is fixed in the up plunging instrument, which, pulled from right to left, locks the up plunger and unlocks the points. Pulling over the points locks this small Sykes's lever, as previously explained, in this position. If a

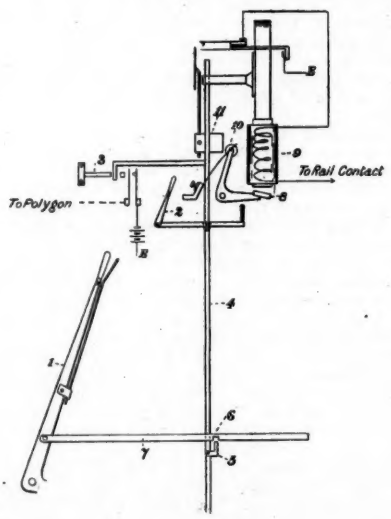


Fig. 26.

train is to be crossed from the up to the down road, the signalman must go through the reverse motions. If, however, an up train *has been* accepted, he is unable to move the cross-over points from down to up; and if a down train *has been* accepted, he is unable to move the cross-over points from up to down, until such trains have passed clear of the section concerned. The small lever normally controls the points. Moved over, it controls the plunger and releases the points, and, the points being moved, locks the small lever in that position.

And here I think I ought to point out why, it seems to me, Sykes's system lends itself most effectually, in the simplest manner, and at the least expense, to sidings, junction, and cross-over working. I have heard it said, even by those for whose opinions on the subject I have the greatest respect, that they have not, and do not require, in their interlocking any back lock for keeping the signal off, until the train itself arrives, and releases it.

They can, it is claimed, always put the signal to danger with their systems. Quite so! and, unfortunately, the lever right back in the frame. It is, I submit, just that which they ought not to be able to do, because, as the lever can be put back in the frame, it releases conflicting point levers and signals otherwise held locked at danger by the ordinary mechanical locking.

For instance, at a junction of converging lines, and where an up train for one road would cross the down road for the other, and *vice versâ*, and the locking of which is on the two home signals, it only requires one of the rods or blades in each Sykes's instrument to be about 1½-inches longer than usual to prevent plunging until the home signal is taken off. When it *is* off, it is electrically back-locked in that position, and you may safely plunge for a train, because it has itself locked, by the mechanical locking, the other contrary signals.

There are many variations of this combination of the locking instrument, the plunger, and the points, together with the small Sykes's lever, to effect different purposes, and facilitate traffic generally, whilst ensuring that every train is within the protection of one or other of the stop signals; sometimes between home and starting signals, and sometimes between the latter and the advance starting signals, the back motion of the leading signal taking the front lock out of the rear signal, and separate rail contacts taking the back locks out of both.

Within the limits of this paper it would not be possible to give, however interesting it might be, the details of the electro-mechanical

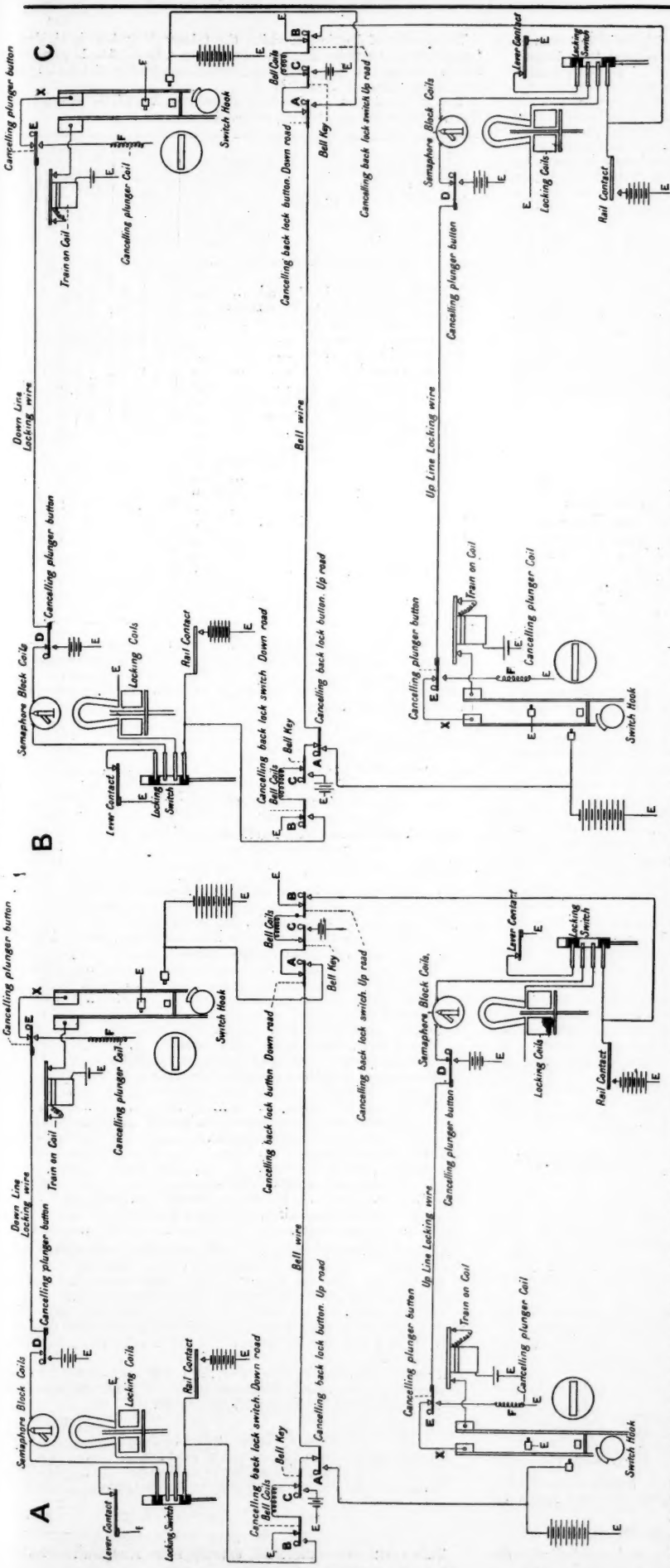


Fig. 27.

devices in use for safely facilitating the traffic in busy stations like Waterloo, Cannon Street and Liverpool Street stations. A lucid description of the electrical devices and combinations for checking and controlling, advising and reminding, and generally assisting the signalmen in safely working the enormous amount of traffic at the different London terminal stations, would be amply sufficient to warrant a most interesting paper on this subject alone.

Cancelling Trains and Resetting Apparatus.

Unfortunately, in all systems of electric interlocking, the exigencies of the traffic seem to necessitate the provision of a key or switch, or other means, to release in cases of emergency. A train which has been accepted may not have to pass through the section, and requires to be cancelled; a defective plunge may not have released the lock (through no defect in the apparatus), or the rail contact may occasionally fail to release the plunger, releasing key, or back lock of the signal lever, or for other reasons. Then the instrument requires to be reset. Undoubtedly the possession of this key in the hands of signalmen, whatever form it may take, is a distinct menace to the security of electric interlocking. Used for its legitimate purpose, only when justified, it is, of course, an advantage in facilitating traffic, and some means *must* be provided to meet such cases, if disastrous delays are to be avoided, on busy lines.

It seems to me that neither the key, nor its equivalent, should be available for use at any one box without the sanction and concurrence of the signalman in advance, or the signalman in the rear, just according to the purpose for which it is wanted. There are two advantages in this, the concurrence of two men at a distance equally responsible, and *proof of the fact of its being used*. I suggest it can be done without extra line wire, by using the bell or locking wire, or both. In the case of cancelling where the plunger or key only is locked, and requires releasing after accepting a train, it is the sanction of the signalman in the rear that should be necessary. Where the train does *not* pass through the section, and over the rail contact, or the rail contact fails to release the back lock after the signal has been lowered, it is the signalman in advance whose sanction, and concurrent action, should be essential.

With the Sykes instrument, to release the plunger a small electro-magnet may be fixed, normally locking the shutter over the keyhole, and thus preventing the key from being put into the instrument, to raise the "Train accepted" disc, without a current from the rear box. In addition to this, the arrangement provides that, unless the key is withdrawn from the instrument *and the shutter placed over the keyhole*, the block bell circuit, or the locking circuit, shall be broken down. This arrangement, necessitating the permission by current from the rear, also limits the use to the occasion, and the particular instrument for which permission is given. To ask for the release of the back lock (or the plunger, or accepting key, in other systems), a bell signal may be given to the box in advance, indicating that a current is required to release the back lock or accepting key. The signalman asking would then depress his receiving key, to switch the current to the locking coils. The actual current would not only unlock the lever, but ring the bell, indicating that the current had passed to the locking instrument. A record of this at both places could be made in the train book.

Diagram, fig. 27 (plate), indicates the complete electrical connections of Sykes's system, and the arrangement applied thereto. The coils to be acted upon for the back lock being polarised, these permissive currents on the Bell wire would be of opposite polarity to the bell currents, as the bell battery is joined up with the reverse pole to earth, so that its current would not actuate them. This ensures that the current transmitted shall be the one *intended for the purpose*.

I have brought a model installation of Sykes's system, representing three stations, "A," "B," and "C" (it was used for teaching,

our signalmen the system of working); and it is fitted with the arrangement for "B" to be respectively released, as regards the plunger, from "A," and, as regards the back lock, from "C," so as to practically demonstrate its applicability. It will be seen by diagram, fig. 27, that the plunger releasing is done on the locking wire and the back lock releasing on the bell wire. The whole additional fittings for each box, with Sykes's system, is a small coil for each locking instrument, and one or two good keys or three-way press buttons.

In diagram, fig. 27 (Plate), the keys, or press buttons, or switches, to *transmit* a current to the rear to release the back lock (equivalent to actuating the rail contact), are marked A; the keys or switches requiring to be depressed to *receive* and divert that current to the coils required, are marked B; and the ordinary bell keys—which are, of course, in actual practice a structural part of the bell itself—are marked C, all in the bell wire. The keys or switches to *transmit* the current to the box in advance, to unlock the shutter, so that the plunger may be reset in case of cancelling, or a defective plunge, are marked D, and are in the locking circuit. The corresponding keys or switches to be depressed in order to *receive* and divert that current to the little shutter locking coil are marked E, and the coils themselves are marked F. In practice, unless the shutter is completely covering the key-hole (in which case the key must be out), the locking circuit is broken down at X. Of course, this is only one way of applying the principle, and it is applicable to any system, and by a separate wire, or otherwise, as desired.

(*To be continued*)

The Société Internationale des Electriciens.

At the sitting of February 3rd at Paris, after the reading of the list of new members and the report, M. Colin gave a description of the principal heating appliances of the Société au Familistère de Guise. These appliances are all formed of metal wires of diameter up to 1 millimetre, buried in insulating material, composed for the most part of powdered glass. The wire can sustain a temperature of 350°. The insulating material melts at 800°. Experiment has shown that an expenditure of 1 hecto-watt-hour is necessary to furnish 86·5 kilogramme-degree-calories. It is estimated, on the other hand, that we must reckon a liberation of 6,€60 calories per square metre of plate per hour. It follows that an apparatus of a surface of 1 square decimetre will consume 1 hecto-watt-hour, and will give off 86·5 kilogramme-degree-calories. In grills for chops and chafing dishes, where the effect must be quickly attained, we must have a liberation of heat of 120 kilogramme-degree-calories per square decimetre of grill; the expenditure of electrical energy is thus 140 watt-hours per hour. For boiling, a temperature or 450° is reckoned for the wire. Experiments have shown that a surface of 1 square metre can evaporate about 100 kilogrammes of water per hour. The quantity of heat to be given off will therefore have to be 536 kilogramme-degree-calories per square decimetre; the expenditure of electrical energy will be six hecto-watt-hours. Experiments have shown that the efficiency of these operations amounted to 80 per cent. A large number of appliances have been established on these principles. We will mention more particularly plate-warmers, grills, and chafing-dishes taking at 110 volts current of from 2·25 to 8 amperes, according to their dimensions. There are also boiling stoves of 5 and 10 hectowatts. The company also supplies heaters for curling-tongs, and special resistances for electromotors and for tramways. Radiating plates can be utilised for the heating of rooms and dwelling-houses.

At the end of the sitting M. Bonfante read a paper on indoor electrical installations. To avoid the dangers of the proximity of the metal parts, he proposed to put concentric cables with the outer to earth, in order to provoke short circuiting, and consequently the rupture of the fuses. These ideas met with opposition from various members.

BRAZILIAN GOVERNMENT TELEGRAPH SYSTEM.

Extract from the Official Report dated 1895, on Telegraphs in Brazil during 1893.

Translated from the "Journal Télégraphique," December 25th, 1896.

The general system of telegraphs in Brazil still continues to be developed in a very satisfactory manner, and during the period from the beginning of 1889 to the end of 1893, the lengths have increased, in all, about 50 per cent., at the following rate per annum:—

	Lines. Kilometres.	Wires. Kilometres.
In 1890	1,784·990 ...	3,422·297
„ 1891	1,535·445 ...	7,969·545
„ 1892	705·684 ...	804·149
„ 1893	1,400·245 ...	1,791·724

At the end of 1893, the whole system had a length of 16,077·805 kilometres of line, and 34,028·981 kilometres was the total length of wires.

Maintenance and Repairs of Lines.

During 1893, the Brazilian Administration, as heretofore, did its best to bring the lines into good order, as well as the land cables.

The number of districts in which the telegraph system is divided for purposes of repairs, &c., has been increased from 16 to 17; and in this is included all lines, and their branches, which were formerly a part of the "Federal Zone."

The *personnel* charged with the maintenance, &c., of the system, is distributed as follows over the 17 districts:—

Number.	Districts.	Chief engineers and assistants.	Inspectors.	Linesmen, &c.	Watchmen.	Workmen.
1	Belem to Engenho Central	1	6	6	...	38
2	Engenho Central to Therezinha ...	1	5	3	40	47
3	Therezinha to Ibiapina	2	4	3	37	1
4	Ibiapina to Itambé	1	5	4	33	18
5	Itambé to Rio Real	1	8	12	35	113
6	Rio Real to Mucury	1	8	7	64	203
7	Mucury to Macahé	2	7	6	33	134
8	Macahé to Angra dos Reis	2	5	6	23	86
9	Angra dos Reis to Iguape	2	7	5	32	55
10	Iguape to Nonohay	2	6	10	33	43
11	Morretes to Torres	2	6	3	21	18
12	Torres to Passo Fundo and to S. Lourenço	2	5	3	22	...
13	S. Lourenço to Sta Victoria de Palmar	1	5	3	19	6
14	Federal Capital to Itabira	1	7	3	20	30
15	Itabira to Januaria	2	5	8	49	52
16	Uberaba to Goyaz	1	5	6	19	12
17	Goyaz to Cuyabá	1	9	6	31	55
	Totals	25	103	94	511	911

The engineer of the telegraph school and the special staff engaged for the maintenance of cables, viz., one ship's officer, one mechanic, one stoker, and six sailors, are not included in the above list.

There were less interruptions, &c., in 1893 than in other years, and the following is a list:—

	1892.	1893.
Interruptions	814 ...	762
Contacts	730 ...	684
Other causes	225 ...	160
Totals	1,769 ...	1,606

The principal causes were as follows:—

	No. of cases.
Broken insulators	41
Contact with poles: In six cases the conductor was attached to the poles by means of gut or pack thread	39
Faults caused by damage to, and contact with, supports, displacement of wires from insulators, contact with other and telephone wires	120
Fallen poles	35
Damaged wires	61
Fallen wire	35
Masts of ships	12
Floods and fall of a wall	4
Fall of trees, branches, and palm leaves	40
Thunderstorms, breaking of insulators, fusion, &c. ...	49
Breaking of insulators, caused by the falling of supports and stays	46
Storms and hurricanes	10
Contact with articles thrown on the lines	12
Contact with walls, gas lamps, &c.	4
Defective insulation	6
Faults in offices	2
Working on, and repairs to, lines	61
Wilful damage, as breaking insulators, upsetting posts and cutting wires, removal of wire	26
Defective sag of wires	4

All river cables connecting the landline system have worked well during 1893. With regard to submarine cables, those laid in the bay of Rio Janeiro were cut when the rebel fleet entered, and they, on the other hand, cut the cable between Mangaratiba and Ilha Grande when they landed on that island, but communication was only interrupted for a few hours. This same cable had already been damaged in April by a mail steamer belonging to the Rio and St. Paulo Steamship Company.

Additional Wires.—The laying of the fourth wire of the Brazilian system, which had already been commenced in 1892, was completed by the construction of 718,618 kilometres, viz.:—

		Kilometres.
District No. 7	From Vendadas Pedras to Campos ...	233,670
	From Itabapoana to Anchieta	73,848
	From Santa Cruz to S. Matheus ...	152,000
District No. 6—From Porto Seguro to Rio de Contas ...		259,100
	Total ...	718,618

This fourth wire, therefore, extends from Mangaratiba, south of the capital, as far as Pernambuco.

Lines Contemplated and in Course of Construction.

With reference to the above mentioned table, showing the lines constructed during 1893, the following observations are made:—

In the construction of the branch line from Raiz da Serra to Therezopolis Manesmann's poles have been for the first time employed. Previous trials show them to be particularly suitable for the construction of telegraph lines in mountainous regions, and in places where transport is difficult.

The line has two conductors between the capital and Nitheroy. This was necessary on account of the interruption of cables across the bay of Rio Janeiro, and to avoid any delay in the service to the north, and especially to Nitheroy.

Pending the construction of this line, the Western and Brazilian Company, for the Government, laid two cables, having one conductor, between the military college and the shore at Tora, near the fortress of Santa Cruz. This was accomplished on November 22nd, 1893. One of these cables, however, being interrupted by a merchant ship, another one was laid and landed at Itaipú, and was securely moored.

The following lines are contemplated, or are in course of construction in the following States:—

Parahyba.—Section between the capital, Parahyba, and the port of Mulunga. This is part of the line which is to connect the first-named place with the town of Areias.

Espirito Santo.—A line from Linhares to Villa de Regencia, at the mouth of the Rio Doce, and a branch line which will connect the capital of this State with the town of Porto do Cachoeira, in Santa Leopoldina.

Rio Janeiro.—The line from Campos to Santo Antonio has been extended from Carangolo to Santo Eduardo.

Santa Catherina.—All has been done preparatory to the construction of a line between Blumenau and Lages, which is to connect the latter town to the general system, and for the establishment of a branch line to connect Torres and Villa de Araranguá.

Pernambuco.—A survey has been considered for a line between Limoeiro and Brejo, connecting Bom Jardin and Taguaretinga.

The establishment of other routes is being actively continued, and are intended to replace the coast lines when interrupted.

Besides the construction of the lines above-mentioned, the following work has been undertaken:—

The construction of a line has been commenced in connection with the line from Therezina, the capital of the State of Piauhy, to Pernambuco, between Therezina and Amarante, which is to be extended to Ouricury, where it will join the State of Pernambuco system.

The work in connection with this line in 1893 had been completed as far as Natal, about 58 kilometres from Therezina.

In the circuit between Recife and Rio Janeiro, plans have been considered for the construction of two branch lines in connection with the existing line between Pesqueira and Alagoâ de Baixo, one to go to São Bento, and the other to Buique. The construction of the section between Villa Bella and Salgueiro has been advanced somewhat, and the work in connection with the survey of a section between Salgueiro and Ouricury has been commenced. This, owing to the lack of means to overcome exploration difficulties in this little known region, entirely lacking facilities of communication, could not be attempted before.

The survey for the extension of the line from Villa Bella and Cabrobo to Boa Vista and Petrolina, has also been completed, and the construction of these lines had already been commenced at the end of 1893.

The work in connection with the extension of the line from Diamantina to Januaria has been advanced from Montes Claros to Contendas. Here it has been stopped to await the results of the negotiations between the Federal Government and the State of Minas Geraes, which latter demanded the adoption of a new plan, taking the line *viâ* San Francisco, thus increasing the length by about 75 kilometres.

The Congress of Minas Geraes are only willing to grant the subsidy if the new plan is adopted, but they are willing to grant 125,000 francs for a branch from Diamantina on the Arassuahy, passing *viâ* Minas Novas and S. Joao de Baptista.

The administration has decided, for the purpose of forming connection between Cachoeira (Bahia) and Rio Janeiro, to construct a line commencing at San Felix, the first station of the Brazilian Imperial Central Bahia Railway Company, thus extending this route to Machado Portella, where it will be joined at Carinhanha to an extension of the Januaria line.

As this line will put into communication a very important mining and plantation district, and will besides connect the prosperous towns of Minas do Rio de Contas and Caiheté, the State Government of Bahia has voted to the administration the first subsidy of 75,000 francs.

Work in connection with this line was started in 1893, and is being actively pushed forward.

Besides this, the administration has commenced the construction of sections from Villa Bella to Jatobà, forming part of a line between Recife and Penedo, and Alagoinhas to Joazeira, for the completion of a circuit from Recife to Bahia and Nonohay to Passo-Fundo for the circuit between Morretes and Porto-Alegre.

There is still to be mentioned the work in connection with the construction of the line from Belem (Pará) to Manaos, which had already been commenced in July, 1892, but had to be suddenly stopped, owing to unforeseen circumstances.

N.B.—Probably due to the concession granted to the Amazon Telegraph Company, Limited, in 1895, for the laying of cables in the Amazon River between Pará and Manaos.

Railway Telegraph Lines.

According to a decree of December 28th, 1870, and Article 8 of the Regulations for the interior service, dated May 2nd, 1890, railway companies must place at the disposal of the State Department o Telegraphs a wire on their posts which must be available for private correspondence.

This, up to the present, has not been complied with, either by railways promoted by private enterprises or by those belonging to the Union; the Central Railway only excepted, it having established such a line on the section between Rio Janeiro and Queluz de Minas, but under their own supervision.

Offices.

In 1893 the number of offices had been increased from 235 to 264, and they are as follows:—

Para	6	Federal District (offices in the town of Rio Janeiro)	16
Maranhao	9	Sao Paulo	13
Piauhy	8	Paraná	17
Ceará...	6	Santa Catharina	12
Rio Grande do Norte ...	5	Sao Pedro do Rio Grande do Sul	41
Parahyba do Norte... ...	2	Minas Geraes	20
Pernambuco	9	Goyaz	4
Alagôas	16	Matto Grosso	6
Sergipe	7	Total	264
Bahia	24		
Espirito Santo	11		
Rio Janeiro	32		

Staff.

The staff engaged in these offices is distributed as follows:—

Chief operators		12
Operators: 1st class		59
" 2nd class		108
" 3rd class		251
Assistant operators: Men		272
" " Women		59
Total		761
Besides:—		
Messengers		355
Office boys		50

(To be continued.)

THE INTERNATIONAL EXHIBITION AT BRUSSELS IN 1897.

The Belgian Government has organised at the International Exhibition at Brussels a scientific section, with the duty of arranging researches, collections and apparatus pertaining especially to the domain of science.

The section is to comprise seven distinct classes, arranged on two main divisions:—

A.—Physical and Mathematical Sciences.

1. Class 80: Mathematics and astronomy; mathematics, mechanics; astronomy; physics of the globe and meteorology; geodesy; topography.
2. Class 81: Physics; metrology (*i.e.*, doctrine of weights and measures; physics).
3. Class 82: Chemistry; physico-chemistry; technical chemistry; photo-chemistry.

B.—Natural Sciences.

4. Class 83: Geology and geography; geogony; applied geology; mineralogy; photography; crystallography; palaeontology; geography.
5. Class 84: Biology; botany; zoology; physiology; bacteriology.
6. Class 85: Anthropology.

Appendix.

7. Class 86: Bibliography.

The Department of Sciences is international.

It will be installed in the right wing of the principal permanent building of the exhibition, and consequently in favourable conditions as regards dangers of fire, damp, &c.

The space allotted to the Department of Sciences will be shared among the different nations represented at the exhibition proportionally to the spaces occupied by each country, but still reserving space for exhibitors not belonging to any of the countries represented.

Persons or societies exhibiting work, apparatus, instruments, and collections falling within the scope of the *Section of Sciences* will have nothing to pay for spaces, decoration, superintendence, cleaning the floors, on condition that their participation is free from any commercial or industrial motive.

Free carriage on the Belgian State Railway is allowed for exhibits of Belgian origin, both for coming and returning. Alien exhibits will be admitted on payment of the usual tariff, but will have free return.

Alien products are exempt of customs charges on landing, but must pay on re-exportation.

All exhibits, Belgian or alien, will be admitted from March 10th to April 10th. They will be definitely arranged on April 15th.

The representatives or delegates of the countries officially represented at exhibition, must send in on or before January 31st, 1897, a detailed account of the space which they wish to be reserved for their countrymen.

Without entirely approving the classification of exhibits here proposed, we must congratulate the organiser of the exhibition in not including political economy and statistics. It must surprise us to find geography classed as a natural science, whilst topography figures as a mathematical science!

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1897.

[*Compiled expressly for this journal by* W. P. Thompson & Co., *Electrical Patent Agents, 322, High Holborn, London, W.C., to whom all inquiries should be addressed.*]

3,248. "A combined switch and brake lever for electric motor vehicles." D. Neale. Dated February 8th.

3,249. "An improved method of gearing for electric motor vehicles." D. Neale. Dated February 8th.

3,279. "An improved means of supporting the cells in electrically propelled vehicles." C. T. J. Oppermann. Dated February 8th.

3,281. "Electric automatic weighing apparatus attachable to any ordinary counter scales or weighing machine." J. Schuil and W. Booth. Dated February 8th.

3,288. "Improvements in electric furnaces. R. C. Conrardo. Dated February 8th.

3,330. "Improvements in electric arc lamps." W. J. Davy. Dated February 8th.

3,334. "Improvements in contact boxes for depressible conductor rails of electric railways." Z. Goodsell. Dated February 8th.

3,346. "Improvements in secondary batteries." C. Payen. Dated February 8th.

3,363. "Improvements in electric cables." S. Z. de Ferranti. Dated February 9th.

3,381. "Improvements in appliances for electrically igniting the explosive charge in gas or oil engines." J. W. Hunter. Dated February 9th.

3,450. "Improvements in connectors for galvanic batteries." G. J. Brown, A. W. Southey and The Electric Motive Power Co., Ltd. Dated February 9th.

3,470. "Improvements in clamp connections for electrical conductors." Siemens Bros. & Co., Ltd. (Siemens & Halske, Germany.) Dated February 9th. (*Complete.*)

3,471. "Safety cut-outs for electric circuits." Siemens Bros. and Co., Ltd. (Siemens & Halske, Germany.) Dated February 9th. (*Complete.*)

3,488. "Improvements in secondary batteries." E. Schattner. Dated February 10th.

3,526. "Improvements in apparatus for the electro-deposition of metals." J. E. Hartley. (Partly communicated by F. W. Zingsem, United States.) Dated February 10th.

3,594. "An improved switch device for common or party telephone lines." J. H. West. Dated February 10th.

3,648. "Improvements in or relating to electric incandescent lamps." F. Ridyard and W. Wardle. Dated February 11th.

3,669. "Advertising on incandescent electric lamps and the like." F. Harrison and H. S. Deacon. Dated February 11th.

3,674. "Telephonograph." J. Clark and J. H. Calcott. Dated February 11th.

3,716. "Improvements in or relating to electric cables for telegraphy and telephony." W. A. Price. Dated February 11th.

3,727. "An improved magnetic toy." J. H. Homeister. Dated February 11th.

3,754. "Apparatus for transmitting electric current to a moving body." D. K. Tullis. Dated February 12th.

3,768. "Improvements in electric traction motors." R. Kennedy. Dated February 12th.

3,772. "Improvements in portable electric lamps for use in mines and other places." S. F. Walker. Dated February 12th.

3,812. "An improved current collector for use in connection with electrically propelled vehicles, and for like purposes. A. Heusch and P. Brandt. Dated February 12th. (*Complete.*)

3,815. "Improved means and apparatus for winding or coiling strips, bands, cords, wires, and other filamentous materials upon closed annular objects, such as cores, or mandrels, for wheel rims, annular dynamo armatures, and the like." J. C. Grant. Dated February 12th.

3,831. "Improvements in or relating to electric batteries." A. R. Adams. Dated February 12th.

3,848. "Improvements in and applicable to electric arc lamps." H. M. Darrah. Dated February 12th.

3,906. "Improved electrically operated switch tongue." E. Andre and A. Silbermann. Dated February 13th. (*Complete.*)

3,914. "Improved means for signalling or advertising at night by electricity." A. Ginisty. Dated February 13th.

3,973. "Improvements in arc lamps." I. H. Hegner. Dated February 13th. (*Complete.*)

3,983. "Improvements in or connected with prepayment meters for gas or other fluid, or for electricity." W Webber. Dated February 13th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Copies of any of these Specifications may be obtained of* Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free,* 8½*d.* (*in stamps*).]

1896.

7,161. "Improvements in or relating to electric light fittings." F. A. Chapman. Dated April 1st, 1896. Relates to an improved electric light fitting and consists of a plug casing placed flush in the wall of a building with two spring contact sides. Into this is inserted the lamp bracket male plug which has likewise two contact pieces. When not in use and lamp bracket is removed, the plug casing has a cover which folds down flush with the wall. 6 claims.

7,556. "Improvements in electric railways on the conduit system." H. C. Regan. Dated April 9th, 1896. The invention consists of a novel construction of electric railway, in which the feed wire is enclosed in an underground conduit, connections being made to the motor on the car through a magnet carried on the car, this magnet actuates switch pieces contained in the conduit, so that convenient lengths of the conductor strips are connected to the main. 13 claims.

7,883. "Improvements relating to the regulation of alternating current electric motors in electric railway and other systems." J. Devonshire. (C. P. Steinmetz and E. J. Berg.) Dated April 14th, 1896. Relates to the regulation of alternating electric current motors used in electric railway and other systems, and particularly to those of the induction type. The theory of the invention is:—In three-phase induction motors an ordinary field magnet winding is used, and the armature of the motor has a regular three-phase winding, which cuts the flux induced by the single-phase current in the field, each phase of the armature generating a certain counter electromotive force. The reaction between the armature electromotive force and the impressed single-phase electromotive force, displaces the electromotive forces at the terminals of the field winding from one another, and, consequently, the tendency of the motor is to displace or split the electromotive force impressed upon it. If the motor be supplied by single-phase current from one transformer only, there is no possibility of splitting the single phase in this way, as the coils are threaded by the same flux; but by employing transformers, one being reversed relatively to the other, the counter electromotive forces of the motor change the voltages at the terminals of the transformer by reflection, and this impresses on the motor itself electromotive forces of different phase relations, tending to increase its output. 6 claims.

8,660. "Improvements in the construction of cells for electric accumulators." F. W. Schneider. Dated April 24th, 1896. The invention is principally intended for accumulators for use in vehicles. The accumulator electrodes rest upon bars of insulating material, and are insulated from one another by perforated insulating walls and by interposed elastic insulating pieces. These pieces lying between the walls of the vessel and the electrodes, receive and neutralise shocks in transport. A cover made of elastic material, and having an enlarged border, is provided, also a tube for conducting away the gases developed in the cell. 2 claims.

9,530. "Improvements in sockets or holders for incandescent electric lamps." J. Devonshire. (H. C. Wirt.) Dated May 5th, 1896. Relates to improvements in sockets or holders for incandescent electric lamps having special reference to the construction of the key shaft and its supporting frame. According to the improved construction the key shaft may be readily inserted in place and removed from its frame by bending a long arm into and out of position thus saving expense of drilling holes in the key shaft. 6 claims.

10,134. "An improved system of and apparatus for the collection of electricity from overhead conductors and in conduits connected therewith." W. J. Brewer. Relates to an improved system of collecting electricity from overhead conductors in which the conductor is mounted direct upon the post without the intervention of any arm or lateral projection other than the insulator upon which the conductor is supported. Another improvement relates to a conduit provided with inclined surfaces whereby a hanging collector under the car is guided into the conduit so as to properly enter the slot in the roadway. 5 claims.

10,492. "Improvements in trolley supports for trolley cars." Otto Holz. Dated May 15th, 1896. Refers to arms and wheels for trolley cars, and the object is to provide a trolley arm with a spring supported trolley wheel. A further object is to provide a combination of two trolley wheels which have peupheral grooves, and which are adapted to be supported side by side, with the trolley wire passing between them. 3 claims.

10,804. "Improvements in electric railways." H. H. Lake. (E. H. Johnson and R. Lundell.) Dated May 19th, 1896. The invention relates to that type of electric railways in which the propelling current is taken from sectional trolley conductors automatically connected to a main supply conductor by the presence of a motor car, and again disconnected therefrom as the car passes on its journey. The invention comprises, firstly, the rendering of the operation of such a system absolutely safe as regards disconnecting the sectional conductors from the main supply conductor after a car or tram has passed, and secondly, the reliability of current supply when such is required to propel the car, and particularly the certainty of not losing the propelling current when running at very high speeds in either direction upon the same track. 5 claims.

10,818. "Improvements in contact making and breaking devices at drawbridges in the overhead circuit of electric tramways." J. Devonshire. (W. B. Potter.) Dated May 19th, 1896. Relates to an improved circuit breaker for drawbridges, by means of which the circuit may be readily and automatically opened and closed between the trolley wire extending lengthwise of the drawbridge and the main trolley wire at the abutments of the bridge. 4 claims.